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The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Empire Iron and Steel

Since the war an enormous change has taken place in the extent to which undeveloped and agricultural countries have become industrially self-sufficing, and some figures have recently been published illustrating the extent to which this has taken place in British countries overseas, to which we sent in the year before the war nearly one-half of our total export of iron and steel. The total iron and steel exports before the war were nearly five million tons, and over two million tons were sent to Empire countries. In 1929, the best year since the war, the Empire countries took 1.7 million tons out of a total export of 4.4 million tons, figures which meant that the change had not been very large. During the subsequent depression these figures, however, fell very materially, the minimum occurring in 1932, when Empire countries took 0.6 million tons out of a total export of three times this figure. For 1934 the figures are 0.9 million tons out of a total of 2.25 million tons, showing a distinct recovery, but still well below 1929. Before the war Canada alone had an iron and steel industry of any magnitude. It was only in 1924 that the Government of India decided to protect the newly-established home industry by means of tariffs, and Indian pig-iron is, as is well known, now regularly exported to this country. The Tata Iron & Steel Company is the largest producer of pig-iron, and practically the only producer of steel in India, its record figure for 1934 being over three-quarters of a million tons of pig-iron and nearly as much crude steel. Australia tells the same story. Before the war almost all Australian requirements were met by imports, and to-day there are two producing companies. The Broken Hill figures for 1934 are over a third of a million tons each of pig-iron and crude steel. While there is a preference for British goods, the tariff is prohibitive, and exports from the United Kingdom are now only about one-third of what they were in 1929. The Canadian industry has naturally been able to draw readily on the experience gained across the border in the United States, and in 1929 over a million tons each of pig-iron and crude steel were produced. Ottawa has changed the 1929 figures for imports into Canada of 80 per cent. U.S.A. and 8 per cent. U.K. to figures in 1933 of 40 per cent. and 45 per cent. In South Africa the Pretoria iron and steel works was commenced in 1931, and again the tariff policy shows a determination to protect the home market. Clearly our policy is to supply higher classes of goods.

Ingot Moulds

The Paper by Mr. Blakiston, which we print in this issue, on the subject of ingot moulds and other steelworks castings, is of considerable interest to both the steel and foundry industries. For the former, it represents, according to the author, a cost of 10s. per ton of crude steel, and to the latter a mine of importance on the behaviour of thick sections under conditions of repeated heatings. Mr. Blakiston's conclusions in general confirm those arrived at by Pearce and Morgan and published in the Fourth Report on the Heterogeneity of Steel Ingots. Ingot-mould life depends on the treatment it receives in the steelworks. An interesting statement has been made by Mr. J. Léonard, the President of the Belgian Foundrymen's Technical Association, in a Paper he prepared for Charleroi Metallurgical Society. He divides ingot moulds into two categories—polygonal and slab moulds—and asserts that the causes of their breakdown in service are totally different. Slab moulds, he asserts, are destroyed through cracking, whilst the polygonal ones finish their usefulness through the deterioration of their internal surfaces, and, because of this, this type of ingot mould should be the subject of research with the object of improving its composition, whilst for the former type the object should be the reduction of internal stresses. His personal researches have resulted in increased life of 50 to 75 per cent. for polygonal and 25 per cent. for the slab moulds. Mr. Léonard's findings agree substantially with those of Mr. Blakiston; he stresses the necessity for the compressibility of the cores, a "lowish" casting temperature, but he prefers top slow pouring to either rapid or bottom pouring.

As the cementite decomposition is one of the causes of the deterioration of an ingot mould, Mr. Léonard suggests that a composition should be used which contains a minimum of graphitising elements, especially silicon, which should be definitely of a low order. On the other hand, the manganese should not be too high, even though it does retard the decomposition of the carbides, because it opposes primary graphitisation initially. He places the limit at 0.4 to 0.5 per cent. Within this range, and with 1.7 per cent. of silicon associated with 3.5 per cent. carbon, good results have been obtained, whilst other

(*Concluded on page* 152.)

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Factors in the Economic Conduct of Vitreous Enamelling

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Further to the recent interesting correspondence on the above subject, there is one important question which has to be settled by a firm considering having its products enamelled. This is whether to put down its own enamelling plant or have the work done by firms which specialise in enamelling "for the trade."

The output of even a small furnace can attain quite large proportions, if operated continuously (as it should be for economic working), and this output should be most carefully estimated and compared with probable sales.

If a plant is installed which is too large for the firm's own work, then outside work is often accepted at uneconomic prices, to the detriment of the trade in general.

I understand that there are at present well over a hundred concerns in this country doing vitreous enamelling, and this fact should be carefully considered by any firms which are thinking of installing a plant.—Yours, etc.,

H. WHITAKER.

"Uplands," View Road, Keighley.
February 20, 1935.

Magnetic Treatment of Enamel

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to Mr. Gray's article and especially to the portion published in your issue of February 7, there are several comments we would like to make regarding Mr. Gray's notes on magnetic separators.

As makers of the first and practically all the magnetic separators which have been supplied to the vitreous-enamelling trades, we look upon the serrated edges incorporated in such machines as an essential feature.

Mr. Gray states that these serrations have a retarding effect on the flow, and that owing to the sluggish action these are unnecessary. With the serrated edges, any magnetic material has many more chances of being caught than if it passes over one edge per magnetic unit only.

The interval between cleaning down which is required when serrated edges are used is far longer than when a plain machine surface only is used, and the slight extra trouble is compensated for by the fewer times the machine has to be cleaned.

It can be easily shown by iron filings on a permanent magnet that the iron will tend to collect at the edges of a magnet, and consequently if there are more edges iron particles are more liable to be caught.

To say that the flow of material is adjusted by regulating the magnetic field is a definite misstatement, as, if the hinged bar is lowered by means of the set screws, it is obvious that the regulation of flow is carried mechanically, and that the strength of the magnetic field has nothing at all to do with the quantity passed.

Also, the statement that the primary magnets are formed of hinged castings should obviously read "secondary magnets," as the primary magnets are mounted below the trough and magnetise the upper bars by induction in exactly the same way as is done in machines we manufacture.—Yours, etc.,

THE RAPID MAGNETTING MACHINE COMPANY, LIMITED.

Birmingham.
February 25, 1935.

Ingot Moulds

(*Concluded from page* 151.)

Continental research workers have standardised on 3.75 per cent. carbon and 1.2 per cent. silicon. Mr. Léonard also attaches considerable importance to grain size. Large grains are too refractory, from the steel-ingot point of view, whilst small grains indicate that the metal has been oxidised. If the cost to the steelmaker for ingot mould and other grey-iron castings is of the order of 10s. per ton of crude steel manufactured, it would appear that a few coppers per ton spent on research would quickly yield a substantial return. Whilst much was made of the question of rough treatment in the steelworks of ingot moulds, we think this was a little exaggerated, for many pitmen take a great pride in achieving long lives for the plant under their charge.

Colonel R. E. B. Crompton's Ninetieth Birthday

The undernoted "Cromptonians" are organising a function to celebrate the ninetieth birthday of Colonel R. E. B. Crompton, C.B., which falls on May 31 next. It has been decided to present him with a portrait of himself at a subscription banquet, invitations for which will be issued in the names of men prominent in the electrical industry. Sir Arthur Stanley, G.B.E., C.B., will preside. Colonel Crompton has expressed the desire to hand the portrait in question to the Institution of Electrical Engineers, and the Council of that Institution have signified their pleasure at the suggestion.

Subscriptions towards the cost of the portrait are invited and are limited to one guinea. Those desiring to subscribe are asked to forward their subscription to the honorary secretary and treasurer as early as possible, and in any case not later than March 31 next. Subscribers will be asked later on to send in their signature for inclusion in an album to be retained by Colonel Crompton as a memento of the occasion. Provisional Committee of "Cromptonians":—Mr. S. L. Brunton; Lt.-Col. K. Edgcumbe; Mr. E. J. Fox (hon. secretary and treasurer); Mr. J. W. Meares; Mr. A. H. Pott; Sir John Snell, and Sir James Swinburne, Bt. Communications should be addressed to the Honorary Secretary at the Manor House, Stanton-by-Dale, near Nottingham.

The Ford Foundries

The Paper which Mr. Vincent C. Faulkner and Mr. J. N. Burns originally presented last autumn on the Dagenham Foundry of the Ford Motor Company to the London Branch of the Institute of British Foundrymen, was repeated last Friday by Mr. Faulkner to the Middlesbrough Branch before a large audience assembled in the Cleveland Technical Institute. Mr. Faulkner added some details on the reclamation of castings.

Resistance to Corrosion and Abrasion

Corrosion tests were recently carried out in a large sewage-disposal plant in America with a view to discovering the most economical material to resist the attack of the sewage corrosive handled. The results obtained from specimens located in different parts of the plant show that cast iron and steel are attacked from four to twenty times faster than Ni-Resist and that copper is attacked from two to three times faster. The resistance to wear offered by Ni-Resist also adds to its value for components subjected to abrasion such as occurs in pump valves, screw conveyors and scrapers.

Random Shots

Miss Nellie Snookers has scored another triumph. She is the first foundry owner to erect an enamelled works-building. When she decided to instal a new enamelling plant at the Gayway Foundry at Eastbourne, the question arose as to what type of building should be erected to house it. The works suggestion box provided many novel ideas, none of which was adopted, however. Miss Snookers herself made the final choice. "We are to put down a plant for vitreous enamelling. Let us demonstrate to the public that we have faith in the properties of our own enamel. Let us, in short, put up an enamelled works. It will be unique; it will be good publicity." "And it will be darned expensive," added Wilfred, chief foundry foreman.

* * *

That was how the undertaking began. The difficulties which were encountered during its accomplishment were enormous. The sides of the building were to be of enamelled iron sheets, and Miss Snookers was insistent that the sheets should be Gayway-enamelled. So the framework of the factory was erected, and incidentally the casting of some of the girders proved to be a troublesome job. Eventually, with sailcloth stretched over the framework, the enamelling equipment was installed and the work of enamelling the sheets began. (It had been suggested that the building should be erected with the bare sheets in place, and that these could be removed one by one for the coating process, but Miss Snookers was against this, as she rightly maintained that pickling costs would then be excessive.)

* * *

What colour scheme was selected? Miss Nellie Snookers had several suggestions prepared in the drawing department. One involved black and white sheets spaced alternately. But this sketch somehow passed into the patternshop, where most of the men are chess enthusiasts, and was not seen again. . . . Another rather similar scheme involved black and white sheets positioned irregularly. This sketch was found to have been filled in as a crossword puzzle before it reached Miss Snookers' office. . . .

* * *

"Marksman" is happy that he was able to supply the scheme that was finally selected. Why not, he said, adopt something in keeping with natural surroundings? The two bottom rows of sheets could be blue-green to represent sea, then the next row be brown to represent shingle, the next twelve rows white (cliffs), a green row (grassy cliff tops), and the top two or three rows of blue and white mottle (sky). Work was begun immediately—and stopped almost as quickly. There was no blue-green enamel in the stores. Wilfred suggested that black enamel might be used, or even red. "You call it a coast-scape, and it might just as well be a coast-scape of the Black Sea or the Red Sea as long as the building goes up quickly," he said. He had been behaving in a rather odd manner ever since the enamelling shop had been suggested.

* * *

The building is now practically completed, and a very handsome sight it is, too. Captain Brian E. O'Shan (retired), the well-known amateur marine artist, who figures so constantly on Beachy Head, was overcome by the sight of it. Miss Nellie Snookers proposes to invite the President of the R.I.B.A. to declare the new works open in the presence of a distinguished company. She proposes also (but hasn't yet done so) to make some small acknowledgment of indebtedness to the originator of the scheme. "Marksman" confesses that he could do with it, for at the moment he is suffering from final-notice embarrassment.

MARKSMAN.

Ingot Moulds, Bottoms and Slag Ladles*

By J. BLAKISTON, A.I.Mech.E.

There are probably no other two industries so closely connected and dependent on one another as the iron and steel and the foundry. Steel rails, billets commence to take shape in the form of a cast-steel ingot. Pig-iron takes its first form as a cast-iron horizontal ingot. Every operation from the colliery to the treatment of the finished product requires a large variety of castings for equipment of the necessary plant. The value of castings represents a figure of approximately 10s. per ton on the cost of the semi-finished products.

Ingot moulds, bottoms and slag ladles accounting for from 2s. to 5s., dependent on the class of material produced, it will, therefore, be realised that every effort must be made to obtain the most suitable and cheapest castings if the cost of production in the iron and steel industry is to be maintained on a competitive basis. This can only be achieved by close co-operation between the foundry and the departmental managers of the iron and steel works so that any experimental work may be closely followed up, and any suggestions may be thoroughly discussed from both points of view.

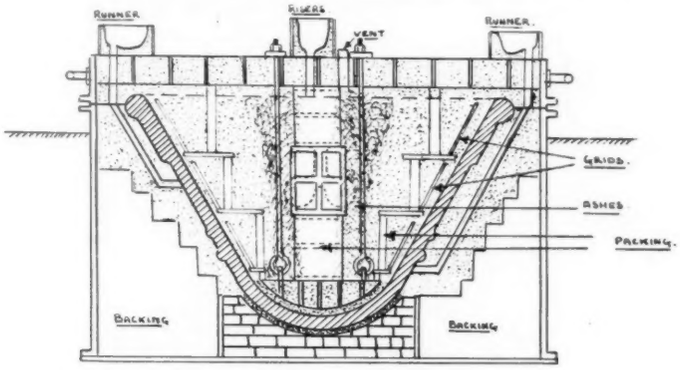


FIG. 1.—MOULD FOR SLAG LADLE.

Standardisation should be sought, as this has a profound effect on the amount of expensive tackle the foundry has to maintain; also a plant's requirements should be studied so as to avoid sudden demands for castings or sudden slackness, which disorganise economic production in both the supplier's and receiver's plants.

It is proposed to give a brief description of the lay-out of a foundry suitable for the production of 400 tons per week of ingot moulds, bottoms and slag ladles. This foundry would consist of one bay 350 ft. long by 50 ft. wide. In the centre of the shop—on one side—would be four stoves 20 ft. sq. Immediately opposite these stoves would be a casting pit of such dimensions as to accommodate a day's cast, viz., 75 tons. At the other side of this pit would be the cupolas. As nearly all this class of work is dry sand the moulding boxes have merely to be lifted straight from the bogies into the pit and the metal straight from the cupolas across to the pit. This obviates excessive travelling on the part of the crane. One end of the shop would be devoted entirely to core spindles and be served by separate pug mill and sand bunker. The other end of the shop would be equipped with a sand-recovery plant together with pug mills and further loam bunkers. These should be adjacent to the fettling benches, so that all sand can be conveniently returned to the recovery plant. The burnt sand as it leaves the moulds is stacked in heaps and covered with clay-wash overnight. It is then put through a disintegrator and is then quite suitable for use as packing sand. The crane power necessary would be covered by high-speed cranes of 20 and 10 tons capacity, particular attention being paid to robustness and fast long-travel motion. The cranes should not be so high as to necessitate a slinger. Two 15-tons per hour cupolas are necessary, the blast being supplied by Roots blowers, fitted with V-rope drives.

Compressed air is necessary for the pneumatic rammers used for the bottoms and slag ladles and the fettling tools. Jarring has been tried on ingot moulds, but does not compare with hand-ramming for speed and output.

The foundry stoves should be either coke or blast-furnace-gas fired, which latter is probably the best drying medium obtainable. Forced draft, in conjunction with coke firing, is not recommended. The stoves should be closed from 3 o'clock in the afternoon until 6 o'clock the following morning; with forced draft proper penetration is not obtained, and whilst 3d. per ton may be saved on the fuel consumption, a 1s. per ton may be lost on the fettling, due to scabbing.

A stove 20 ft. square requires 5,000 cub. ft. of blast-furnace gas per hr., and if properly controlled excellent drying is obtained. Coke-oven gas is not recommended on account of the heat being too fierce and local, and the hydrogen content which creates additional moisture when burning.

As facilities, and not elaborate equipment, govern the cost of the product, careful attention must be paid to see that the men have good hand tools available at the position most convenient for the operation to be performed. Much time is lost in foundries by moulders wandering about looking for articles which should be kept in close proximity to the job in hand.

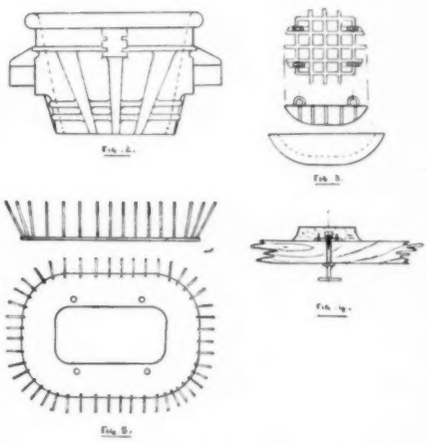
All handling of material should be done by means of skips, so that the capital cost of the cranes are exploited to their maximum. Barrows and similar methods of transport should be eliminated. Two separate portions of the foundry should be reserved for the moulding of circular slag ladles and Dewhurst-type ladles, so as not to interfere with the principal castings being produced, viz., moulds and bottoms.

Methods of Moulding Slag Ladles

Briefly described, circular slag pans are invariably swept in loam. A special cradle, with trunnions mounted on crank arms, is used to enable the core to be readily turned over after it is dry. The process being well known, there is no need to enlarge upon it. Dewhurst-type ladles are best manufactured in pairs, using a double pit. These ladles, the mould for which is shown in Fig. 1, weigh approximately 10 tons. A wood pattern is made similar to Fig. 2, from which the mould and core is made. The trunnion and ribs are loose, and are fixed for moulding by means of T-headed bolts, Fig. 4. The bottom part of the pattern, Fig. 3, is made from cast iron. To commence moulding, the bottom part of the pattern is loamed out and a grate, with four loops cast in it, is bedded into it and loamed up flush with the top of the casting. This is dried in the stoves.

The mould (Fig. 6) is made in a cast-iron box which is sunk in the foundry floor. These are in pairs; an inner box is bricked up roughly to the contour of the cast-iron portion of the pattern. This brickwork is covered with a layer of 1 in. of wet loam with which a little fireclay has been mixed. The cast-iron portion of the pattern, containing the bottom grate for the core, is then taken from the stove, and, whilst still hot, is bedded into the loam. This forms a semi-permanent part of the mould, which may last several castings. The wood part of the pattern is then placed on the top of the iron part. The mould is then rammed up on the outside with strong milled loam. At the same time, the core is rammed up from a similar sand. The prints on the pattern are readily released, as this proceeds by means of the T-headed bolts. Three or four grids as illustrated in Fig. 5 are placed above each other from the grate. These grids are packed from one another and gaggers are placed in between the prongs. In the centre of this core further packings are placed in the form of open-sided boxes, which are surrounded by cinders to vent the core. The core and the top box are in one—the whole mass is tied together by four bolts pulling from the bottom grate to the top box. The nuts of these bolts are pulled very tight, so as to ensure that the core is not disturbed by any sag which may come on the top box when the core is handled—parting is facilitated by the use of parting plates made of thin sheet-metal or parting sand may be used.

The top box and core are then lifted, blacked off and dried. They need not be turned over, but supported at each corner by pillars (Fig. 7). Basket fires are placed on the four sides, and the lot is surrounded by corrugated sheets. The wood portion of the pattern is withdrawn from the mould, leaving the cast-iron part remaining in the bottom. This is used by the men to stand on whilst dressing and blacking the upper portion of the mould. For drying, a fire is suspended in the centre of the mould. The pouring is done as quickly as possible by means of two ladles; risers are placed immediately over the trunnions where feeding takes place until the casting has solidified. These ladles are often required to be split in halves or to have a detachable bottom. The moulding process for these is exactly the same, wrought-iron splitting plates being used to divide the casting. The box is weighted in the centre as well as being clamped



FIGS. 2 TO 5.

* A Paper read before the Middlesbrough Branch of the Institute of British Foundrymen, Mr. J. Hackwood presiding.

to obviate any spring that may take place on the top. Ramming is done by a heavy type of pneumatic rammer. Two moulders working two pits can produce two ladles per week on this method.

Ingot Moulds

There are two principal types of mould—closed bottom and the open type. The design has a very big influence on the after-performance of these. There is a tendency when any trouble is experienced due to cracking to thicken up the mould at the point, without any consideration or forethought. This probably will only aggravate the trouble through creating further internal stresses. In one instance it was found that removal of only a quarter of an inch of metal from the thickness at the bottom of the mould increased the average life of a 7-ton mould by 10 per cent. A thin mould will resist cracking much better than a thick one, on account of being able to distort more readily to the shape to which the heat stresses in it lead. The use of internal steel reinforcements are useless on account of the unequal expansion of the different metals.

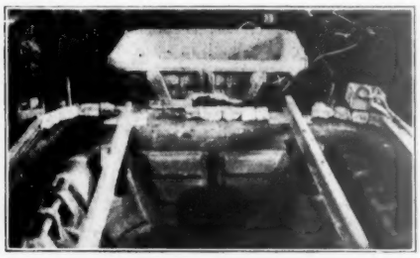


FIG. 6.—MOULD FOR SLAG LADLE.

Should trouble occur on moulds that have hitherto given a successful life, much consideration must be given before any attempt is made drastically to alter the section, and if any alteration be then made, it should be slight, and the results carefully followed up to ascertain if any improvement is going to mature. The moulding is carried out as shown in Fig. 8.

The mould is made up of four portions the bottom plate, the mould box, the core barrel and the top cake plate. The core barrels are shaped to the internal size of the mould, and are lapped with a thick layer of straw rope by suspending them from a wall crane with a ball-bearing swivel hook, and spinning them round. The barrels are then placed in the coreboxes and rammed up with extra heavy-milled loam. In the case of the core for the dummy mould a grate is attached to the bottom of the core barrel; the corebox is split down the sides and has a detachable bottom. Well-greased wing nuts are used on all coreboxes to save time. The cores are blacked off and hung on special racks constructed on the core bogie.

Some foundries use circular core barrels, but this, of course, is impossible for large-plate moulds. The boxes are rammed up by hand in a pit, the moulds being backed up with the sand from the recovery plant. The pattern is ejected by means of a screw jack which clips on to the box. This saves damage to pattern by eliminating the use of hammers. The moulds are then placed on a small gantry so constructed that a man can stand up inside them to spray them with blacking; from thence they are transferred to the stoves for drying.

Wrought iron lifting lugs which are cast into the top of the ingot moulds are loamed into the slots provided in the cake plates. When dry, the moulds are assembled directly into the casting pit, which should be roomy to enable the men to work freely. The core on the open type mould is set by calipers, an electric candle lamp being dropped in between the core and the mould for inspection.

The core at the top is located in position by the loam-cake which, as well as holding the lifting lugs, has four or more holes provided in it for the runners, so situated as to obviate the liability of the metal striking the core or mould sides while casting is in progress.

A circular sand runner is formed on top of the cake plate; any tendency for the cake plate to lift is counteracted by bars inserted through the side of the box. The core is maintained in position by its own weight.

On the closed bottom moulds the core is held by a cast-iron cross bridging the top of the box, adjustment being made by means of wedges. The cake plate in this instance is in halves, and tends to stop any further rock on the core.

A more accurate procedure for moulding open type moulds may be followed by having the mould bottoms and the core spindle in one piece, but this method takes up considerably more stove room, and foundry space for no greater output.

After the ingot mould has been cast the core barrels are removed as soon as possible, also the cast-iron moulding boxes leaving the moulds covered with a layer of loam. The moulds are stacked together so as to retain as much of their heat as possible, and are allowed to slowly cool for 24 hours, when the sand may be stripped off and they are ready for fettling.

It is important that the core barrels be removed early so that no contraction stresses are created, as these have a big influence on the life of the mould. If the moulds were placed in an adapted Gjers soaking pit and allowed to anneal themselves for several days, it would be found that their average lives would be considerably increased.

For fettling, the moulds are placed horizontally on a gantry—a whole day's cast being laid out at once immediately adjacent to the trucks for loading them out. Hand-pneumatic chipping hammers are fitted with a sword-like chisel about 4 ft. long, and if the grade of sand be kept correct and the blacking properly executed three fettlers can comfortably fettle 400 tons of castings per week.

Bottoms

These may be made in green sand, dry sand or in permanent moulds and chills, dependent on the subsequent class of steel to be produced. If the life of the bottoms be determined by the cutting action of the steel on it, when the ingot is poured and the quality of the steel is such that no protection may be used on the bottom, a green-sand mould with a chill top is probably the cheapest method for making bottoms. If the bottoms can be protected from the cutting action of the steel, and the life is determined by how long the bottoms can remain in situation without developing extensive cracks, they should be made in dry sand with permanent tops. In all cases the bottoms are moulded in boxes on a turn-over board. If made in green sand, the bottom box is separated from the sides with inch packing pieces; this gap is used for the insertion of the vent rods, which is imperative.

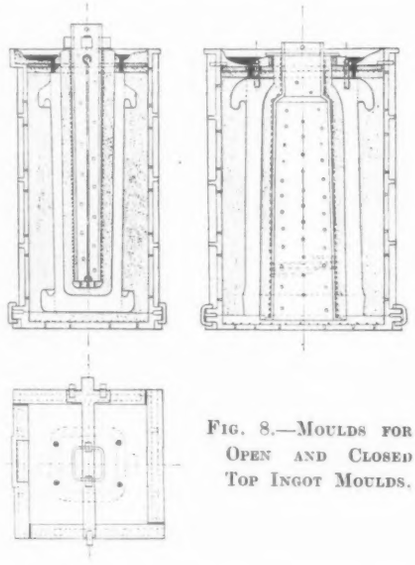


FIG. 8.—MOULDS FOR OPEN AND CLOSED TOP INGOT MOULDS.

The chills are 9 in. thick, and will last many years, and holes are placed in them to accommodate the riser and runner. Should any lugs appear on the top of the casting, whistlers naturally will have to be placed in the chill to prevent entrapping of gases. The chills are removed immediately the metal has set to prevent any of the top lugs of the casting shearing off by contraction, and also to allow the casting, assisted by the remaining heat, to relieve itself of any of the stresses set up by the chilling.

FIG. 7.—CORE FOR SLAG LADLE.

When made in dry sand, the moulds may be dried by resting a hot ingot mould from the previous day's cast over them. The permanent top is made by mixing best Leeds fireclay with loam and plastering it on to a 3-in. thick cast-iron plate. Before drying, this loam is nicked into 9-in. squares, so irregular fire cracks are avoided. After drying these nicks are filled up. A permanent top of this description has lasted 100 casts with very little patching. It, however, must only be placed on thoroughly dry moulds. Should it be placed on a green sand or an undried mould, its life will be very short. Permanent bottoms made in a similar manner have been tried out, but on account of building up the sides with moist sand, their life is limited to six casts at the most.

(To be concluded.)

Lake Superior Ore Shipments

Iron ore shipped from the Mesabi range in 1934 was 67.07 per cent. of the total amount despatched, as compared with 62.3 per cent. in 1933 and 54 per cent. in 1932, according to the annual report of the Lake Superior Iron Ore Association, covering water shipments for the year. Non-Bessemer ore shipped comprised 70.74 per cent. of the total of 22,027,055 tons shipped as compared with 68.8 per cent. the previous year and with 67.2 per cent. in 1931. Bessemer ore shipped declined and was 23.28 per cent. of the total as compared with 26.4 per cent. in the previous year. Shipment of silicious ore increased to 521,251 tons from 332,842 tons in 1933.

Oxy-Ferrolene Steel-Cutting Method

Several advantages are claimed for the "Oxy-Ferrolene" method of cutting steel by using impregnated coal gas—instead of acetylene—in conjunction with oxygen. Among these is a saving in cost of from 33⅓ per cent. to 40 per cent. as compared with acetylene. It gives a better cut in that the cut is narrower and the edges are not hardened. The effect of the impregnation of the gas is to lower the ignition point and retard the propagation of the flame so that its cutting value is increased to a marked extent. In fact, the speed of the cut in various thicknesses is increased at the rate of 1 in. in 4 in. Another important point is the absence of carbide residue. The concern marketing the process is the Oxy-Ferrolene Company, Limited, Piccadilly House, W., and Messrs. George Cohen, Sons & Company, Limited, of 600, Commercial Road, London, E., have taken over the agency for the South of England.

Rotary Melting Furnace Practice*

By S. E. DAWSON, F.I.C., A.M.C.Tech.†

Introduction

When one discusses a rotary melting furnace, one almost automatically visualises a modern, well-equipped foundry, producing high-quality iron and castings, under very rigid control as to analysis and strength, and all those other factors associated with up-to-date methods in foundry practice available to-day.

This view is perhaps brought about largely by comparison of this form of melting with the cupola, which for so long has provided the principle melting unit in the foundry. This it has done to good purpose, especially in the earlier years when cast iron was looked upon somewhat as a Cinderella of the materials employed in the engineering industry. This was no doubt due to its limitations in strength, elongation and homogeneity which were for so long accepted as being fundamental characteristics of the material.

Recently, however, such great strides have been made both in regard to its properties and the methods of production, that its status has been raised to one of paramount importance in almost all industrial duties and designs. Indeed, the progress of development of cast iron during the past 30 years or so may well rank as one of the great engineering achievements of modern times.

So successful has this been that not only has cast iron been brought towards the region of steel, so far as mechanical strength is concerned, but its composition and structure has been so modified that its application in other fields has been widely increased, and the engineer may well look forward to still further improvements in the many directions in which the investigations of the metallurgist are proceeding.

Such modifications in the structure of cast iron include the production of fine grain and graphite, which are essential qualities for high strength, efficient plating and galvanising, low internal shrinkage, freedom from porosity to withstand high pressures, resistance to wear, ease of machining and chill control. Further, the effects and characteristics given by alloy additions, such as nickel, chromium, molybdenum, vanadium for special-duty purposes such as heat and acid resistance, rolls, etc., are all evidence of the increasing application of modern cast iron.

Of equal importance has been the improvements in foundry-melting plant, to some extent brought about by the necessity of producing such high-grade and special cast irons in the foundry in a commercial and economic manner.

This is perhaps the latest fundamental direction to which research has been applied in the foundry, and has resulted not only in improved cupolas, but also in an entirely new type of melting unit known as the rotary furnace, a furnace singularly well adapted to meet the more exacting and wider ranges of cast iron which modern research has brought into use.

Such furnaces are better compared in their action with the electric melting furnace than with the cupola, for the heat power is produced outside the bath of metal to which it is conveyed by the rotary movement, through the medium of the refractory lining, which thus serves the dual purpose of protecting the steel shell or container barrel, whilst storing up heat to be transferred to the metal, thereby avoiding undue losses and contamination by gases, fuel, etc., as in the cupola.

The fuel employed in these furnaces is coal or oil and therefore more nearly approximates in melting cost to the cupola than to the electric furnace of relatively high current cost.

Description

The following is a brief description of the design and working of the Sesci type of furnace:—The furnace body consists of a steel shell mounted on two tracks, which run on oscillating rollers. The body is lined with a rammed acid lining about 14 in. thick, and is rotated by means of a motor, gear box and chain drive. This rotation gear is also arranged so that a very slow motion is used for tapping purposes. At the combustion end of the furnace is fitted a special burner, which in this type is specially designed for the combustion of anthracite or semi-anthracite fuel. The opposite end of the furnace is connected by a movable head to the flues. The products of combustion are led first to the recuperator and then to the chimney.

Air Supply

The air supply is provided by a Roots-type blower, which delivers a constant volume of air for a constant speed. This air is then carried through a recuperator and preheated, according to the progress of the melt, up to 600 deg. C. It then passes under the coal hoppers, where it receives the coal, which in turn is measured out by positive screw feeders, and then to the furnace. At the point where the pipe line joins the furnace a rotary airtight joint is fitted, which prevents any loss of the carefully-measured-out air and coal. As the motors for the blower and coal feeders are variable-speed type, any quantity of air and fuel can be delivered at once at the will of the operator. An important point about this type of furnace is that all the air entering the furnace is directly controlled, thus permitting accurate control of flame and atmosphere.

Coal

Two kinds of coal are used. First, a soft or bituminous coal with a volatile content of 30 or 35 per cent. This is used only in the morning, when lighting up a cold furnace. After the melt has progressed until the ingoing air has reached a preheated temperature of about 220 deg. C., the main coal supply is turned on and the soft coal replaced. The anthracite type of coal contains from 4 to 12 per cent. volatile matter. The best results have been obtained from coal with about 10 per cent. volatile. The moisture content of the coal is best kept below 2 per cent. for the efficient working of any pulveriser. The pulveriser should give consistent results and a finished product that will pass 85 per cent. through a 200 mesh per in. sieve, with the coarser grades suitably balanced. Any decrease below 75 per cent. will transfer carbon to the charge and make the resulting analysis in error. The ash content of the coal is immaterial to the final results, except that a corresponding increase in coal consumption will be apparent owing to the loss in calorific value. Coal is usually used containing from 5 to 8 per cent. ash.

Table I shows analyses of typical coals which have been used satisfactorily:—

TABLE I.—*Composition of Anthracite Coals.*

	Moisture.	Fixed carbon.	Ash.	Volatile.	S.	B.T.U.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Welsh	1.15	92.70	3.30	4.00	0.18	14,200
,,	1.23	90.60	4.20	5.20	0.38	14,700
,,	1.40	91.80	3.90	4.30	0.22	14,300
,,	2.76	90.30	3.80	5.90	0.23	14,800
Scotch	8.60	80.54	6.60	12.86	0.28	14,700
,,	9.14	84.57	2.43	13.00	0.19	15,300

One of the greatest benefits conferred by the rotary furnace on the foundry industry is its adaptability to melt and convert to the correct analysis almost any raw ferrous materials. Cast-iron scrap of any shape up to the size that will pass the charging door and down to borings can be easily melted. Steel also presents no difficulty, and with the aid of two such materials and a supply of ferro-silicon, ferro-manganese and ferro-phosphorus, any particular analysis can be produced.

Allowing for charging and tapping, it is possible to obtain four heats daily from one furnace in a normal working day. One feels that a continuous system would assist the lining to give of its best instead of a daily heating and cooling which is always bad treatment for refractories.

It has been observed that the mechanism of the process consists of introducing heat into the rotating furnace with the object of raising the refractory lining to a very high temperature, the hot products of combustion then passing forward into the flues to the chimney stack.

The intense heat in the furnace lining is transmitted during rotation directly to the metal bath by actual contact, thus overcoming the heat-insulating power of the slag, which, however, protects the metal from contamination by gases. The heat is generated by the burning of the pulverised coal on a refractory lath-type grid situated in the combustion chamber, somewhat on the principle of a Bunsen burner with its gauze flame carrier. The coal is carried in and burned by means of an air supply raised to a suitable temperature in a regenerator situated in the exhaust flues, and driven forward by the blower. The coal, except for that used in the initial lighting-up, is anthracite and can be obtained from any suitable coal measure, typical analyses of such having already been given. Since the main feature is to concentrate the absorption of heat into the bath of metal, it is necessary to control the combustion of the coal—that is, the flame—at a position predetermined in the design of the furnace. This position is immediately in front of the grid in the combustion chamber.

Owing to the easier ignition of the higher-volatile coals the position would vary with this factor. Consequently, for increased volatile in the fuel the temperature of the combustion air must be lowered to maintain the correct position. The following examples show the balance which has to be observed:—7 per cent. volatile requires 550 deg. C. air temperature; 11 per cent. volatile requires 450 deg. C. air temperature; 15 per cent. volatile requires 350 deg. C. air temperature. Fig. 1 shows this relationship over a considerable range of coals, the upper range indicating a series of temperatures which might cause damage to the grid and which should be avoided. The degree of pulverisation of the coal has also some influence on the position of combustion, but with suitable modern pulverising plant this can be closely regulated. The air temperature is controlled by the use of damper plates in the exhaust flues, which include a by-pass direct to the chimney.

Lining

The lining of the furnace, put in by pneumatic rammers working round templates, as in the Bessemer converter, is composed of such a material as to embody high refractoriness, resistance to the abrasive action of the charge and the air blast, little or no expansion or contraction, and an elasticity to withstand varying temperatures. Such materials are usually of a siliceous nature, containing about 30 per cent. of clay, and after ramming the lining is skin dried and fired, prior to glazing under full heat.

The preparation of such a refractory material, not only as regards its properly-balanced grain sizes, but also as to its thorough maturing and to a correct moisture content before applying, is of great importance. Of no less importance is the method of application into the barrel, since the final density after fritting should be as near as possible to that of tridymite, namely,

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* Paper read before the East Midlands Branch of the Institute of British Foundrymen, Mr. A. E. Peace presiding.

† The Author is Chief Metallurgist to the Stanton Ironworks Company, Limited.

2.2 to 2.3, in order to avoid undue internal movement due to expansion or contraction, especially in the early stages of the conversion of the silica or quartz. Such precautions have a great influence on the life of a lining, and, after much experimenting, 150 to 180 melts are now being obtained per lining in cast-iron practice.

Charging

The charge is introduced through the exhaust end of the furnace after removing the flue head to one side, and is carried out by a charging machine similar to that employed in the steelworks, the skips being previously loaded at the weighing machine.

Operation

The furnace is lit up with soft coal by means of a few sticks placed in front of the grid and ignited through the lighting hole in the combustion chamber. When free combustion has thus been started, the soft coal is gradually replaced by hard coal and full heat attained with the barrel meantime rotating. The charge, if not already put in after the previous night's shutdown, is then introduced with the furnace stationary and the blast reduced. The movable head is then replaced, and full blast recommenced.

The first heat usually takes about 3 hrs., the second about 2 hrs., and subsequent ones about 1¾ hrs., the charging in between heats occupying about 10 min. on the medium-sized units. The whole of the controls for rotating, tapping out, etc., are operated electrically, and by means of push-buttons suitably disposed for the convenience of the operator. The personnel required to operate, say, a battery of four furnaces, is as follows:—One melter, two tappers, one charging-machine man, and two men for the preparation of charges. For a less number of furnaces, of course, these cannot be dispensed with *pro rata*, and so the cost of labour per ton is somewhat heavier in this case. This also applies to repair labour, and to some extent to those retained for lining the barrels.

Costs

The costs, however, could be said to be 13s. to 16s. per ton to cover most cases, and would be made up approximately as follow:—

	Per ton. s.	d.
Hard coal at 20s. per ton .. .. .. } Soft coal at 10s. per ton .. .. .. }	4	0
Pulverising	0	7
Limestone	0	2
Power at ¾d. per unit	1	3
Labour	1	6
Lining costs	2	8
Maintenance	2	0
Depreciation and interest	2	0
	14	2

Overheads are not included in the above figures since these will vary with each individual case.

Results

From the foregoing it will be seen that the rotary furnace provides conditions for producing metal, not only free from the effects of contamination necessarily associated with cupola practice, but one of a predetermined composition, and of a range hitherto not economically possible. The cupola, with its circumscribed heat range and direct contact between descending metal and ascending gases, has largely controlled and limited the composition and structure of cast iron produced therefrom.

It has long been recognised that vastly different structures could be obtained with the same composition if only means of production were available economically and conveniently to provide a suitable range of the necessary conditions.

The controlled effect of superheating cast iron is to produce in the final solid material a pearlite-fine graphite structure, to an extent dependent on the degree and length of time of such superheat. Such a structure, in addition to thus embodying the most desirable components of the iron, has the added interest and value of exhibiting a lower shrinkage and a more even grain size for different metal thicknesses, a property hitherto attainable only by alloy conditions or special processes. This is clearly illustrated in the case of automobile cylinder blocks where the variety of sections necessitated are produced in regular and equal structure.

The theory underlying this fine-graphite formation is generally ascribed to the more complete solution of the original flake graphite in the materials employed, with the consequent removal or reduction in size of graphite "nuclei" which would induce and form the starting point of large flake graphite. This is only partially correct, however, and much investigatory work is proceeding in an effort to determine a more comprehensive understanding of the matter.

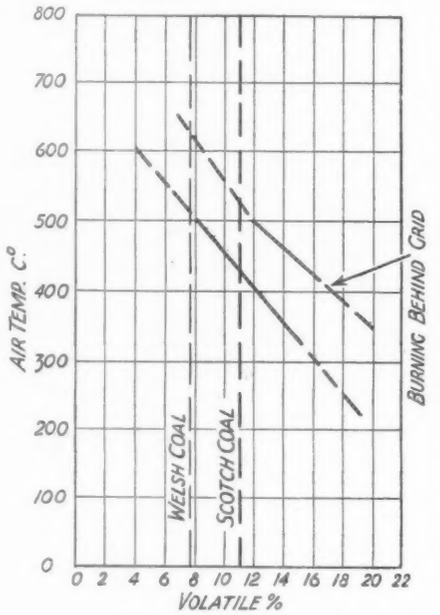

FIG. 1.—INFLUENCE OF VOLATILE CONTENT ON TEMPERATURE OF AIR.

Some scientific evidence is, however, hereby shown for the use in most cupola charges of "scrap" which, whilst introducing a serious unknown factor into the calculation, is of finer-graphite form than "pig," due to its having been twice melted. The extent to which superheating should be carried out depends on the duties to be demanded of the castings produced from the metal, the proportion of pearlite retained being the main underlying factor.

Recent work carried out by the author with the Stanton Ironworks Company has also strongly emphasised the value of close-grained fine-graphite iron in the stabilisation of a strong eutectic eminently suitable for the manufacture of spun pipes.

From the foregoing, it is natural to assume that a more complete control of total carbon in the metal would facilitate the production of a desired structure if, for example, a low carbon could be employed. The superheat attainable in the rotary furnace renders this possible, since steel, or any other low-carbon material, can be melted with ease, and any degree of carbon introduced into the melt by the addition of petroleum coke if necessary.

The use of steel in the cupola charge, even if under limited control, is one evidence of the value of lower carbon towards improved structure. Low total-carbon cast iron, in addition to producing fine graphite, also produces a finer grain structure, which, as one would expect, is responsible for great increase in strength. The new process of rotary melting has, therefore, provided a means of embodying the factors necessary to bridge the gap between grey cast iron and malleable cast iron, and, by superimposing the malleable process thereon, of attaining strengths usually only attributed to steel.

Similarly for special-duty conditions, alloy cast iron of any desired composition can be made, either as a complete and separate melt where quantities warrant it, or by adding the alloying elements, including carbon, in a residual furnace bath or in the ladle.

In concluding, the author wishes to thank the directors of Messrs. Armstrong Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne, for kindly supplying slides.

DISCUSSION

Opening the discussion, the BRANCH-PRESIDENT (Mr. A. E. Peace) said the lecture was to have been given by Mr. C. A. Scott, of Newcastle. Mr. Scott had, unfortunately, another meeting on this date, and Mr. Dawson had kindly consented to give the Paper in his place.

Furnace Linings

MR. PYATT (Leicester) said the rotary furnace had come to stay, and was a far better melting unit than the cupola. He had an idea that in the future, perhaps the distant future, there would be small units attached to cupolas. What method had the author used for determining oxidation, and what precautions were taken on the shell for the expansion of the lining? He asked the latter question because no expansion rings were shown on the photographs, so he (Mr. Pyatt) assumed that the lining was so balanced as to eliminate expansion. With regard to the figures of 150 to 180 heats per lining, he thought the silica content mentioned was rather low to obtain that number of heats. What amount of patching was done to the lining in order to obtain those heats from one lining? He had noticed the furnace was fitted with two tap-holes. Was one of these used for a slag-hole?—as if so he thought one would have to use a high percentage of limestone to liquefy the slag. What carbon pick-up did one get from pulverised coal as compared to an oil-fuel furnace? Could Mr. Dawson give comparative fuel costs of pulverised coal and oil?

Fuel Costs

MR. DAWSON said oxidation was below 2 per cent. in the rotary furnace. The furnacemen became very experienced in judging the appearance of the flame and could control oxidation by the amount of coal used. His experience was the air supply should be 160 cub. ft. to 1 lb. of fuel. In the rotary furnace one worked far more accurately than in the cupola. The small loss was indicative of better conditions. Expansion rings were not needed if the lining was properly constructed. If one did want allowance one might arrange expansion rings. It was a simple matter to allow for expansion, by not ramming too hard. The danger was in ramming insufficiently to withstand the rotation. The figures given for life of a lining ignored patching, being for a lining with no patching whatever. Both tap-holes were for metal; the slag is taken off through the same hole after the metal. The limestone used, 1½ per cent., was the normal amount to use. He had no experience of oil-fired furnaces, but quoting from maker's figures the fuel cost was 10s. for oil as against 4s. for coal, and against that the makers of oil furnaces claim quicker melting times.

Lining Preparation

A VISITOR from the South Wales Branch, speaking of mesh sizes for the silica lining, asked if he had understood correctly that one degree of fineness was the better or should it be a mixture of varying meshes? When mixing

the lining material, was the water added a little at a time over four to five days or was all water added initially and then left to mature? He was very interested in the rotary furnace, but for his work would only require a small unit, and he would like Mr. Dawson's opinion as to whether a pulverised-fuel furnace would be satisfactory for a ½-ton melting unit. He understood the length of the flame was a deciding factor and wondered whether it was feasible for a furnace so small as ½ ton. He understood the extra strength was obtained at some high temperature, but it was not always advisable to pour castings at that temperature. Did one let the metal cool down, and how did that affect graphitisation? Was this type of furnace suitable for melting, say, ordinary steel and high-chromium alloys?

MR. DAWSON replied that one wanted mixed mesh rather than otherwise for the refractories. The procedure was to lay down 2 or 3 in. of material and add a little water, then another 2 or 3 in. of material and a little more water, and so on, and then leave the whole stock to mature for a period of four or five days. He thought in a ½-ton furnace that would be workable. He had no experience of so small a unit. The length of the flame was of importance, and therefore there must be a low limit for furnace sizes, and he would think the one suggested would be near the limit.

The metal temperature was raised in the furnace, and was then cooled off either in the furnace or in the ladle to the suitable pouring temperature. The superheat having dissolved the graphite more thoroughly, gave a finer-grained metal. Melting steel and alloys was very easy in the rotary furnace.

Metallic Losses

MR. DOLPHIN (Birmingham Branch) asked what were the losses of carbon, silicon, etc., in this type of furnace. He had experience of oil-fired furnaces, and he found the losses to be fairly high. Had Mr. Dawson any experience in recarburisation, as he had found it necessary to add carbon owing to heavy carbon losses? Using a very high steel percentage to make cast iron, he thought, would necessitate recarburisation. At what part of the melt would the author introduce the various alloys? If one added chromium, one could lose 50 per cent. of the amount charged. His experience and difficulty in adding molybdenum had been in getting the alloy beneath the slag covering the bath of metal. What procedure was carried out for the drying of the lining before putting the shell back on to the furnace? He had found that, if they dried with coke fires for a week, there was still a quantity of moisture left in the furnace, which steamed out when working.

MR. DAWSON said he had found the metal losses to be rather less than in the cupola. Carbon, for instance, was about 2½ per cent. of the total carbon. The same applied to silicon losses in the 10-ton unit. In a 5-ton unit the losses were about 5 per cent., and in the 2-ton unit about 7½ per cent. Mr. Dolphin was evidently getting about 14 per cent., which was very high, and he thought there must be an oxidising flame. For recarburisation he used petroleum coke, and it was the best policy to add this when the metal was in the pasty stage. It should be of walnut size. Alloys could be added when the metal was ready, left for about 15 min., and the charge then tapped. Molybdenum was only added in very small quantities, so it was better to add this in the ladle. It could be put in the furnace, but a small quantity like 0.5 per cent. was easier to add in the ladle. It was easier to dry a lining with hot air than with a coke fire. He used an ordinary mould drier.

Firebrick Linings

A MEMBER asked whether it was necessary to have a spare shell for relining, and was that owing to the time to reline? Considering that one cannot give the same attention to the drying of a lining as a firebrick in a kiln, what was the disadvantage of a firebrick lining? What was the lining thickness?

MR. DAWSON said the spare shell was not a necessity. It took about five days to reline a shell. Lining thickness was 17 in. for a 10-ton furnace, 14 in. for a 5-ton and 10 in. for a 2-ton. Firebricks had the disadvantage that one had a weak structure because of the joints. Any lining was better than bricks, if properly put in as one piece.

Recuperation

MR. H. L. SANDERS said one part of the installation that had not been mentioned was the recuperator. He assumed that was of the type made up of tubes, and as they had to stand up to 600 deg. C., he would like to know whether the tubes were refractory. Was the weight of the charge in the furnace increased as the lining burnt back? Was not superheating a disadvantage, inasmuch as it gave a graphite and ferrite structure instead of pearlite. This structure would give strength, but would fail on wearing qualities.

MR. DAWSON said the tubes in the recuperator were made of treated steel. As the lining wears the charge could be increased if desired. He should have said, when referring to superheat "controlled superheat," as about 1,620 deg. C. is the point where pearlite is resolved into ferrite and graphite, but up to that temperature one could operate satisfactorily.

MR. A. E. PEACE asked what was the temperature of the waste gases passing into the recuperator. The anthracite carried from 0.1 to 0.2 per cent. sulphur; what would be the sulphur pick-up in a low-sulphur iron of, say, 0.05 and 0.07 per cent.?

MR. DAWSON said the air is passed over the tubes which stand across the flue and air is heated up to 550 to 600 deg. C. The temperature of flue gases would be from 700 to 800 deg. C. The sulphur pick-up was very low, about 0.01 per cent.

MR. DRIVER proposed a vote of thanks and MR. W. T. EVANS seconded, which MR. DAWSON acknowledged.

Catalogue Received

Electric Cranes. Herbert Morris, Limited, of Loughborough, have prepared a special catalogue—No. 189—dealing with overhead electric travelling cranes. We were concerned, well over twenty years ago, with the purchase of the first Morris crane ever installed in a steel works, and it is pleasing to note the real progress effected in what was then an excellent piece of machinery. Lubrication has had special attention, whilst the gears, by the look of them, should be much quieter in operation. As a constant visitor to works of various kinds, we always appreciate a crane, which is reasonably quiet and one that does not spray our clothes with oil. The former permits of easy conversation, whilst the latter tends to keep our tailor's bill within reasonable proportions! An outstanding feature, which will be appreciated by the foundry industry, is the dead-slow gear for stripping the patterns from the moulds. In the old days there was a preference for d.c. cranes, as a.c. were said to "snatch," but this creeping gear has, we understand, eliminated this difficulty.

Top-Charged Electric Furnace

According to a recent issue of "Heat Treating and Forging," a new electric furnace having a capacity of 20 tons is to be installed by the International Nickel Company at their Huntington plant. This furnace is to be top-charged and it is claimed that in basic practice the savings will be: Power 5 per cent.; electrodes 14 per cent.; refractories 30 per cent., and man-hours per ton 30 per cent.

Iron and Steel Federation

EARL OF DUDLEY ELECTED PRESIDENT

At the annual general meeting of the British Iron and Steel Federation, held in London on Thursday, February 21, the Rt. Hon. the Earl of Dudley (Chairman of the Earl of Dudley's Round Oak Works, Limited) was elected President for 1935. The Earl of Dudley is the present representative of a family whose connection with the iron trade dates from the early 17th century. In addition to being the chairman of the Earl of Dudley's Round Oak Works, Limited, he is chairman of the Baggeridge Colliery, Limited, and Edgehill, Limited. He is chairman of the Council for Research on Housing Construction, and in 1926-27 was the President of the Society of British Gas Industries. Lord Dudley sat in Parliament for Hornsey Borough from 1921-24 and for Wednesbury from 1931-1932. From 1921-23 he was Parliamentary Private Secretary to the Under-Secretary of State for India.

THE EARL OF DUDLEY
(President, British Iron and Steel Federation).

The following were elected Vice-Presidents:—Sir John Beale (chairman, British (Guest Keen Baldwins) Iron & Steel Company, Limited), Capt. R. S. Hilton (managing director, United Steel Companies, Limited), Sir Charles Craven (deputy chairman and managing director, English Steel Corporation, Limited), Mr. Lawrence Ennis (managing director, Dorman Long & Company, Limited), Sir William Firth (chairman, Richard Thomas & Company, Limited), Mr. J. E. James (chairman, Lancashire Steel Corporation, Limited), Mr. C. W. Kayser (chairman and managing director, Kayser Ellison & Company, Limited), Sir James Lithgow (director, Colvilles, Limited), Mr. A. K. McCosh (director, Wm. Baird & Company, Limited), Mr. A. C. Macdiarmid (chairman, Stewarts and Lloyds, Limited), Mr. Henry Summers (chairman, J. Summers & Son, Limited), Mr. A. J. Wesson (chairman and managing director, W. Wesson & Company, Limited).

Sir William B. Peat was elected first Honorary Vice-President of the Federation.

"International Labour Review"

The "International Labour Review" for January contains two special articles, one on "Trade Associations and Corporations in Italy after the Recent Reforms," by Anselmo Anselmi, and the other on "The Place of the Doctor in Factory Inspection," by Dr. L. Tellsky. Reports and inquiries include "The Application of the New Social Insurance Legislation in France"; "The Depressed Areas in Great Britain"; "Proposals for a Policy of Migration within the British Empire." The usual statistics are included. Copies of the "Review" may be obtained from Messrs. George Allen & Unwin, Limited, Ruskin House, 40, Museum Street, London, W.C.1. (Price 2s. 6d. post free.)

Uniformity in Finished Castings

CAST-IRON PIPES

By D. R. KINNELL*

This title offers a wide scope for discussion, but the writer intends only to elaborate on methods of finished cast-iron pipes. Unquestionably appearances sell a casting as much as reputation, and to this end it will be found that a good, clean and well-dressed pipe will sell in preference to a pipe which, although of correct size and weight, etc., and free from flaws, has not the surface and finished care of its competitor. If one pipe casting can be manufactured and dressed so as to appear satisfactory, then it is best to set a standard in respect of this and endeavour to obtain like results on all castings of this type.

Undoubtedly a firm which gives consistently well-dressed castings commands more respect and repeat orders than a firm where castings are well dressed after a complaint has been registered, but at a later date the finish again deteriorates. It must not be understood from the foregoing that the writer believes whatever state a casting has been sent up from the foundry to the dressing shop, a satisfactory job can be made of it. This is not the case, although numerous firms incur serious costs of tackling the job at the wrong end. Obviously, unless the rough casting is good, and by that it is meant reasonably smooth, etc., it cannot be well dressed. Consequently the first phase to tackle is that of "moulding."

Taking the old and well-tried method of moulding, *i.e.*, on a "bank," or on the "level," depending on the type and weight of pipe poured, it will be found that so long as the moulder is on piecework, the shorter the time in which he can make his squad of good pipes and be finished, the better he is pleased, but in some cases no individual thought or pride is taken in the finish or appearance of the dressed pipes, providing they are good castings.

Parting Powder and Surface

On looking further into the question of moulding, it will be found that the cope and drag-pipe box parts are rammed up in the usual way and then the pattern withdrawn, and in order to facilitate this withdrawing of the pattern a very liberal application has been made of parting sand on the joint, which usually consists of dried sea sand or else sand from the spare pig beds, the trouble being that the sand goes as much in the top and drag parts of the box as in the parting joint. This parting sand so used, although very helpful and beneficial to the moulders, is definitely detrimental to the employers, and on examining a finished pipe made in this way it is found that the coarse grains of the parting powder are adhering to the outside of the pipe, having fused to it when the pipes were cast. In most cases they are so hard and ingrained that only persistent filing will remove them.

There are several good makes of mineral parting powder on the market which it will well repay any employer to purchase for the moulders, when a good clean casting will be obtained and casting will not be found rough. The question of parting the mould is only half the battle, and to ensure that the whole of the finish of the outside of the pipes is good, it is necessary that the men be taught to use the best quality blacking in the copes and drags of the moulds, and after applying this that the whole of the mould be "sleeked" and made thoroughly smooth.

In the above case, the amount of powder used per pipe is very little once the moulders have been taught the correct method of application, whilst the cost of powder in bulk is not great. Considerable saving is obtained if moulders are supplied with canvas bags in which to keep necessary powder, the mesh of the bag being such that the powder will fall out in small quantities when vigorously shaken on to the parting of the moulds. The question of sleeking tools, etc., as before mentioned, should be examined by the foundry management, and if the men do not supply them themselves, they should be supplied as one set to each moulder and his mate.

Improving Bore Finish

The finished size and surface of the bore is governed entirely by the core, which in the majority of cases is in dry sand, the mixture of the sand varying with the type of pipe and the metal thickness demanded. The remarks regarding the mixture of the sand also apply to the mould. If the core sand be satisfactory with regard to the strength, etc., the main constituent which governs it is the blacking, made up into "blacking wash" for easy application by the moulders. The methods of application for this blacking wash are various, *i.e.*, from pouring on by hand from tin or small bucket to the use of compressed-air spraying on to the core, this being the preferable method. In fact, any method whereby the mixing of the wash is taken out of the hands of the moulders as far as possible is desirable, in order to get uniformly smooth bore pipes. Given all the above details and correct pattern, corebox, corebars, etc., and metal, the initial casting should be good providing it is moulded properly.

Dressing Shop Conditions

Assuming these conditions, and the fact that the casting has been made satisfactorily, it now passes to the dressing shop, and the method of dressing all pipe castings is as follows. Providing the casting is good—and by this is meant free from large projections, etc., and well run—there is no need to employ men as dressers, but youths can do this job quite easily, although in the case of heavy pipes, such as cold-water main of 6- to 8-in. bore, it is advisable to employ one man to remove the runner gates of these pipes with hammer and chisel, which job a youth would not possibly be able to do satisfactorily.

The first operation is usually cleaning of the bore of the pipe. This is done by passing through the bore by mechanical methods or by hand a wire brush, which is a very tight fit on the bore. If this is pulled up and down two or three times, from the socket end, the bore will be found to be as clean as possible, providing the core has been thoroughly black-washed. Probably, the mechanical-coring devices are best, but the expenditure for plant of this type is excessive for small foundries.

After this the casting is usually "sanded" with a wire brush all down the outside. This can be done quite satisfactorily by hand. The pipe is then dressed by hammer and chisel, in case there are any roughnesses along the join of the body, and also the gate is chipped off smoothly.

Then the socket of each pipe is given individual inspection and cleaned thoroughly, as it is essential that this be as free from sand as possible, and follow exactly the pattern of the corebox, because no very large limits are allowed for caulking up these pipes, and in some cases, unless some care is taken with regard to sand inclusions, when the pipe socket is mated up with other pipe spigot, there will be no room for caulking tools.

The writer has found that the best method of cleaning these sockets is with a small electric rotary machine, with a suitable wire brush fitted, and this is put into each socket in turn until it is satisfactorily cleaned, each pipe operation taking about 7 sec.

Testing Methods

The casting, now dressed, is passed on to some parallel rails and rolled in order to see whether it is, in the first case, straight, and, secondly, whether the metal thickness is consistent in all parts of the bore. Given two parallel rails for rolling, it is easily seen whether the pipe is fairly straight or either "up" or "down," by the method in which it rolls along the rails.

If passed as satisfactory, it is then put on to the hydraulic machine for water test, and also to have the studs caulked up by hammer and punch. Providing it withstands this pressure satisfactorily, the pipe is then completely in order, although in many cases pipe has to stand back for some considerable time owing to sweating gates in the case of H.W. pipes or porous parts, which are easily remedied by the application of sal ammoniac.

The foregoing notes have been taken from the general working conditions of a small foundry, and the author has not entered into the technical side of the question at all. The details given are essentially practical, but it is hoped that it will prove useful to some small foundry owners and managers.

* Assistant Works Manager, Chas. P. Kinnell and Company, Limited, Thornaby-on-Tees.

Vitreous Enamellers

MIDLAND SECTION'S QUESTION NIGHT

The success of a Question Night held during February has encouraged the Midland Section of The Institute of Vitreous Enamellers to contemplate further meetings of the kind. Questions submitted by members will be welcomed by the Committee. They may be either signed or anonymous, and the Committee wish it to be known that, because a member sends in a question, it does not necessarily imply that he should take part in the discussion. If he does not desire to do so, the Committee would arrange for some other member to take the lead in the discussion on the question.

On the initiative of MR. A. E. REED, the following questions were considered by the February meeting:—

(1) What actually happens when epsom salts or any other setting-up agent is put into a quantity of enamel?

(2) Why is it that an article can be sprayed in a light colour such as cream, light green, etc., and fired in a furnace which is leaking, and yet show no signs of gas, while the same article sprayed in black, blue, red or brown will definitely show signs of gas?

(3) Why is it that gum arabic can be freely used in colours made with transparent frit, while if used with colours made with opaque frit, it immediately takes all the surface away?

(4) What is the difference between a cast-iron enamel and a sheet-iron enamel?

(5) Does finely-ground enamel give better results than the same enamel coarsely ground?

(6) Is it possible to "speed up" an enamel?

There was a well-sustained discussion, in which the following members took part:—Dr. Angus, Messrs. Blair Allen, England, Grainger, Gray, Griffiths, Hallsworth, Lawrence, Sellars and Todd.

Mr. Reed was cordially thanked for introducing the series of questions.

SWANSEA CORPORATION ELECTRICITY COMMITTEE recommends the tender of £7,185 of the Metropolitan-Cammell Carriage & Wagon Company, Limited, for the supply of thirty 20-ton covered steel wagons.

Foundry Costing*

By J. ROXBURGH

Dealing with foundry costing, the author feels it would be superfluous to give consideration to the various systems in vogue of collecting the costs, as all must be familiar with some type of system, and it is only a matter of how far one wishes to go into the analysis of the costs and in some cases to what length one is prepared to go in spending both time and money to secure efficiency. There must be some method of determining whether a profit is being made as a whole, or in each department or process, or ascertaining any waste that may be taking place or some weakness in the management.

What is really of greater importance to founders is the use of these costs, when tabulated in a definite and in an intelligible form, to help one to estimate an economic selling price for foundry products with some degree of confidence. Therein lies the significance of such costs, as the costing which takes place after the order is completed is the accountant's affair.

Therefore it is assumed that everybody agrees that, to run a foundry successfully, one must have accurate knowledge of the costs. Undoubtedly, increasing competition has brought the subject of cost accounts very much to the front in recent years, and it has been a case, more often than not, of getting down to rock-bottom prices and believing that the price quoted was low enough to have a reasonable chance of being accepted and, at the same time, sufficiently high to cover the cost of the work, allowing for all indirect expenses and possibly a slight margin of profit. At other times, under special conditions, the founder has had to be content when only a percentage of the recognised charges have been recovered, a matter which will be referred to later.

Unfortunately, there has been so much evidence, in recent times, of the existence of the competitor who, one can only surmise, has but a rough-and-ready method of costing and who, perhaps, has faith in the idea that what he loses on the swings he will gain on the roundabouts. No doubt everybody has wondered at times how these people continue to carry on their particular business.

Cut Price Competition

A more insidious form of competition, which is perhaps not as obvious, is indulged in by certain foundries which have a very good remunerative line representing a good proportion of their output, maybe a monopoly, where exceptionally high prices are obtained, and the profit accruing from this line is used to subsidise, consciously or otherwise, work of a competitive nature, affording them the opportunity of quoting cut prices to the disadvantage of other foundries whose whole output is competitive.

For a long time now, certain sections of the foundry industry have felt that this unfair competition, whatever form it may take, should be given serious consideration, and at last a committee, connected with the Institute, will shortly be in a position to present a Report and probably recommend a universal system of costing in this country. Of course, it will only be a recommendation after all, and it remains to be seen what reception will be given to it by the foundries themselves.

In endeavouring to provide a standard system of costing, the author can envisage many problems which will render the task more difficult. It will be granted that foundry costs raise problems peculiar to themselves, as the foundry is actually creating articles from the raw material and using a great variety of other commodities in the process, quite different from most of the other engineering trades.

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. W. N. Cook presiding.

Everyone is cognisant of the variation in production in the various foundries, and, in many cases, in the same foundry itself. Some foundries make heavy types of castings entirely, others light castings, whilst both heavy and light castings may constitute the output, or there are the foundries which specialise. Again, the processes by which the castings are produced vary, the three chief processes being green-sand, dry-sand and loam moulding, which may, very often, be carried out in the same foundry.

In a foundry, where each section or job does not bear its own legitimate share of oncost, one section must, of necessity, be subsidised by the other. Where an accurate cost system does not exist, allowing for the separation of these sections, the overheads and incidental expenses are spread over the total output, rendering it unavoidable that one section is carrying more oncost than it ought rightly to do, by virtue of the less expensive character of its manufacture in all its phases, whilst another section is insufficiently burdened.

With regard to repetition foundries which use machines entirely, the costs are fairly simple and lend themselves better to a standard system of costing, the only vexed question being the method to be adopted for recovering the money for the use of the machines, some foundries taking depreciation of the machines into consideration, whilst others advocate that the estimated output of castings numerically be spread over.

Continuing the consideration of the difficulties of providing a standard system of costing, everybody realises that the foundry industry is not stable, either as regards quantity or character of its output, and the question arises as to what suitable period of time will be recommended for estimating average output and for overhead charges. The establishment charges, obviously, remain practically constant whatever the output. When the output is reduced, therefore, and the charges remain constant, naturally the percentage overhead figure increases, but, of course, the market price for the castings remains the same, as naturally, the market is competitive, and so any work must continue to be quoted for on the average percentage overhead, with the hope that the volume of work subsequently obtained over a period will prove, or otherwise, the accuracy of the estimated average overhead percentage.

Taking this a step further, however, supposing after a period of activity the foundry finds itself with hardly a job in the shop. What is the policy then, and how would the advocates of the standard system of costing view this situation? For the time being, would it pay the foundry to accept work at a slightly lower price than usual and thereby help to pay at least a percentage of the charges, which have still to be paid, work or play? Doubtless this policy has had to be adopted at times, but, of course, it could not continue for long.

Costs which Govern Selling Price

First, there are the *direct costs*, such as moulding and coremaking. In some foundries, coremaking is undertaken by the moulder, in which case the two costs can be assembled together as the direct cost, eventually carrying the estimated overhead percentage. The coreshop in other foundries is quite a separate department, with its own personnel and tackle, and therefore, under such circumstances, any coremaking must bear the overheads of its own shop. When all is said and done, a selling price depends initially and essentially on the direct labour cost, as the overheads, to which reference will be made later, should be expressed as a percentage of this cost. For that reason, it is emphasised how essential it is that the person selected to give an estimated figure for the moulding and coremaking of a new job, whether it be from drawing or actual patterns, should be one definitely qualified for the job in a practical sense. That is, one skilled in the reading of a drawing, acquainted intimately with all the practical details involved, the tackle available or required, the adaptability of his various workmen, and the class of work his foundry is best suited to produce.

Indirect Costs

Indirect costs are made up (1) of all indirect labour in the foundry, viz., sand preparation, stove attendants, general labourers, cranemen, supervision, storekeepers, etc.; (2) materials used, viz., general stores, sand, coal dust, blacking, plumbago, gas coke, etc.; (3) power, repairs, tools, maintenance, management, etc.; (4) establishment charges, viz., rent, rates, taxes, insurance, depreciation, office staff, etc. The first three items are variable, while the last is fairly constant, and these four items constitute the overheads to which reference has been made.

Fettling Costs

Fettling costs may be taken as a direct or indirect cost. If taken as a direct cost, then fettling cost must bear the oncosts of its own department, which are (1) wages; (2) weighing and inspecting; (3) upkeep of plant, maintenance, power, etc.; (4) depreciation, rent, rates, taxes, etc. Where the products are of a like nature, an average figure can be given of so much per ton for fettling, but where there is a great variety of castings, an endeavour should be made to group the castings together and so have a range of figures per ton to cover the respective costs.

Melting Costs

This item deals with the cost of the metal at the spout, and includes: (1) Cost of metal, (2) loss in melting, (3) attendants, (4) fuel, stores, ganister, limestone, bricks, etc., (5) repairs and upkeep, laboratory, power and depreciation, rents, rates, taxes, etc. The total metal cost to be included in the estimated selling price is the metal cost and melting cost on the finished weight of casting. The selling price of any castings can therefore be estimated as follows: Direct cost; + per cent. overhead of the direct cost; + fettling (or included in the per cent. overhead); + total metal cost; + profit; + carriage.

The two items in the above which seem to give rise to the greatest controversy are the ascertainment of the total metal cost to be charged and the allocation of the overheads, and therefore it is proposed to deal more fully with them.

For the purpose of illustrating melting costs a definite case can be taken, which will give due regard to the actual metal cost and to the subsequent scrap. Suppose a 4-ton casting is to be made, requiring a definite analysis including 0.4 to 0.5 per cent. Cr, 95 cwts. will then be required in the ladle for casting purposes to allow a sufficient margin for runners, risers, etc. Taking into consideration the melting loss of, say, 5 per cent., it will be necessary to charge 5 tons on the cupola. In order to obtain 0.4 to 0.5 per cent. Cr in the casting, 0.6 per cent. Cr must be charged in the mixture, approximately 25 per cent. loss being allowed when using 60 per cent. Fe Cr. By a simple calculation it can be found that 1 cwt. Fe Cr must be used for this purpose. Supposing the cost of metal, without the addition of the alloy, is £4. To this must be added the melting cost, say 12s. 6d. per ton, the total being £4 12s. 6d.

Having taken 95 cwts. in the ladle to cast a 4-ton casting, there remains 15 cwts. of scrap. How must this, then, be considered from the point of view of costs? If there is only one casting to be made, the matter is simple. The customer should be charged with 1 cwt. of Fe Cr,

60 per cent., at, say, £24 per ton, in addition to the ordinary cost of that iron.

The metal cost, therefore, for one casting would be:—

	£ s. d.
4 tons at £4 12s. 6d.	= 18 10 0
1 cwt. of Fe Cr at £24 per ton	= 1 4 0
	4) 19 14 0
	4 18 6 per ton.

In this case the alloy addition has been paid for and the 15 cwts. scrap, now containing 0.4 to 0.5 per cent. Cr would be left on the hands of the foundryman, as only one casting has been made, and really the only value it has to him is the ordinary market value for scrap of that nature + 12 lbs. Fe Cr, *i.e.*, 3s., which is not worth quibbling about, and could be allowed for if there were more than one casting to make, as the 15 cwts. of chrome scrap could be used up in subsequent mixtures. Then instead of adding 1 cwt. of ferro chrome to obtain the desired percentage, the amount required now is 1 cwt. less 12 lbs. (present in the 15 cwts.), *i.e.*, 100 lbs.

The metal cost in this case would be:—

	£ s. d.
4 tons at £4 12s. 6d.	= 18 10 0
100 lbs. of Fe Cr at £24 per ton	= 1 1 0
	4) 19 11 0
	4 17 9 per ton.

This, of course, can be calculated in another way. 15 cwts. of scrap can be used up in five 20-cwt. charges as 3 cwts. to the charge, resulting in 3 cwts. of chrome scrap + 17 cwts. of the other metal. Then

3 cwts. scrap × 0.4 Cr =	1.2
17 cwts. pig-iron × 0 Cr =	0
20	1.2

1.2 ÷ 20 = 0.06 per cent. Cr. It is required to charge 0.6 per cent. Cr. 100 cwts. × 0.6 = 60. Now 100 × 0.06 = 6. Therefore, the amount to be added is 54.

Then cwt. of Fe Cr is to be added

$$= \frac{54 \times 112 \text{ lbs.}}{60} = \frac{6048}{60} = 100 \text{ lbs.}$$

At the end of the order there would still be 15 cwts. of scrap left, and this cost, if thought necessary, could be spread over the total castings so that the customer pays for it.

The same weight of casting may be taken again, introducing 2 per cent. of nickel. On 5 tons charged it will be found, taking nickel as 100 per cent. and costing £200 per ton, that 2 cwts. of nickel is required. On a similar basis for costing, the following is obtained:—

	£ s. d.
4 tons at £4 12s. 6d.	= 18 10 0
2 cwts. of Ni at £200 per ton	= 20 0 0
	4) 38 10 0
	9 12 6 per ton.

If there were more than one casting to make, then the 15 cwts. of scrap could be used up, as previously instanced. Then, instead of adding 2 cwts. of nickel, 2 cwts. less 34 lbs., *i.e.*, 190 lbs., should be incorporated. Taking 4 tons at £4 12s. 6d., which is £18 10s., and 190 lbs. Ni at £200 per ton, which is £17, and dividing this total (£35 10s.) by four, gives the metal cost, *i.e.*, £8 17s. 6d. per ton.

Therefore, alloy irons should be regarded as certain mixtures of iron at the calculated value plus a definite value of alloy for the casting. Cr and Ni additions have been dealt with first of all, as it was felt that in this way the exact cost of additions would be immediately obvious and easily arrived at.

Standard Mixtures

Most foundries, probably, have at least one standard mixture of iron which is used regularly over a period of six or twelve months. Supposing this mixture is made up of bought iron and resultant shop scrap. By taking stock at the beginning of the six or twelve months and the purchase of iron during that period less the stock at the end of the period, you know the exact cost of iron used for this standard mixture during that time. Providing that the amount of scrap in stock at the end of the period is roughly equivalent to that at the beginning, then the cost of the bought iron divided by the output of castings, will give the actual cost of metal, to which, of course, must be added the melting cost. In this case the cost of the metal mixture is the pig-iron price.

Table I.

		Tons.
Total metal charge per annum *i.e.*, 21 tons for 250 days.	=	5,250
1st day charge 11 tons pig-iron. 10 tons bought scrap.		
Each day after 11 tons pig-iron 10 tons shop scrap.		
Good castings produced	=	2,500
Total Metal Cost—		
Pig-iron 250 × 10 = 2,500 tons at £3 10s. per ton	=	£ 8,750
5,000 tons at 8s. 6d. (melting cost including loss in melting)	=	2,125
		10,875
Per ton good castings	=	10,875 / 2,500
	=	£4 7s. 0d.

The good castings produced comprise 50 per cent. of metal at the spout. £4 7s. represents £3 10s. (price of pig-iron) + 2 × 8s. 6d. = £3 10s. + 17s. = £4 7s.

There still remains 10 tons of scrap, the valuation of which is similar to initial bought scrap.

On the other hand, if scrap has had to be purchased outside and included in the mixture, together with a definite percentage of domestic scrap, the purchases of iron and outside scrap can likewise be obtained from the purchase journal and the average price for metal calculated. In this way, the domestic scrap is not given any inflated value, as a percentage of such scrap is always incorporated in the mixture, and whatever the value placed upon it, it can make no difference to the ultimate cost of the metal. To be more explicit, if 30 per cent. of domestic scrap were used regularly, together with 70 per cent. of bought iron, then the cost of the metal is the cost of the bought iron divided by the output of castings derived from the mixture over a given period, and there will still be the scrap at the end of this period. The scrap can be valued at market price which obtained at the commencement of the period, the only possibility of variation being the fluctuation of the market.

In the foundry to which the author is attached, there are definitely two regular mixtures of iron, one mixture on one cupola and one on the other and their costs can be kept separate. For instance one mixture consists of 50 per cent. common pig and 50 per cent. scrap, and so the total purchases of iron can easily be obtained. The price of the domestic scrap does not really enter into the value of the metal, as all the scrap is melted up, and should there be more scrap available than usual the proportion of scrap in the mixture can be varied or, if they run short of shop scrap, a percentage outside scrap is introduced, which can be taken also as a purchase.

In the other cupola, a semi-steel mixture is run every day, consisting of steel scrap, hematite, ingot mould, common pig and the return scrap. This return scrap is always approximately a constant percentage of the charge and the value of the other items, which are bought, can easily be extracted and the total tonnage of castings made in a certain period taken into consideration to obtain the average metal cost.

In addition to these two standard mixtures, orders are executed for castings demanding special mixtures of iron, and the composition of these charges can always be obtained from the cupola charge sheets, and can be treated individually (as has been previously illustrated in the instance of Ni and Cr irons) if desired. When estimating, naturally these special irons are given special consideration, as shown in Table II.

Table II.

8 ton finished press head casting.

T.C.	Si.	Mn.	S.	P.
3.30	1.20	0.70	0.090	0.40

	Per cwt. s. d.	s. d.
4 cwts. cold blast iron	9 6	38 0
2 „ hematite	4 0	8 0
2 „ Thorncliffe No. 4	3 6	7 0
8 „ own refined scrap	4 0	32 0
4 „ bought scrap	3 0	12 0
		97 0
Metal Cost—		s. d.
10 tons at 97s. per ton		970 0
10 „ at 8s. 6d. per ton		85 0
		1,055 0
Less 2 tons at 80s. (high quality scrap)		160 0
On 8 ton casting	8)	895 0
		111 10

i.e., £5 11s. 10d. per ton.

True Valuation of Scrap

Some foundries, in dealing with their scrap even go so far as to place their different scraps in separate piles in the stock yard and give them some appropriate letter or marking. They weigh all the scrap produced in the foundry each day and credit such scrap to its corresponding pile in the yard, and then, from the particulars detailed on the cupola charge-sheet, consider any scrap taken from the yard in a light of a purchase by the foundry, in this way keeping an accurate tally of all the metal and scrap used. This can also allocate the value to them, based on market price, and indicate what irons they are capable of replacing in a mixture by virtue of their metallurgical value. A suggestion which merits consideration is illustrated by Table III, which shows a classification, according to values, of pig-irons and scrap, ranging from the expensive cold-blast iron down to cheap common scrap. It should be borne in mind that the values shown are only for the purpose of illustration. The various grades of scrap can be kept separate and stocked in the yard, and can be regarded in a similar light to the stocks of pig-iron. This point should be emphasised, as some people are apt to regard scrap as being of one kind only, whereas it should be common knowledge that there are many types of scrap, resulting from differing mixtures of iron, in the first place, and showing marked differences in fracture and analysis. Scrap, the qualities of which are known, is of great value to the practical foundryman, and if used with discrimination can definitely improve a metal mixture. By allocating a value to the scrap, as outlined above, the question of domestic scrap derived from special mixtures, as distinct from that derived from standard mixtures, used over a period, would cease to present any difficulties, as the customer could then be charged with the depreciation of the scrap between the value of

Table III.

	Per ton. £ s. d.
Cold blast pig-iron	9 10 0
Refined iron	6 0 0
Cylinder iron	5 10 0
Hematite iron	4 5 0
High quality scrap	4 0 0
Ingot mould scrap	3 10 0
Common iron	3 8 6
Steel scrap	2 15 0
Common scrap	2 10 0

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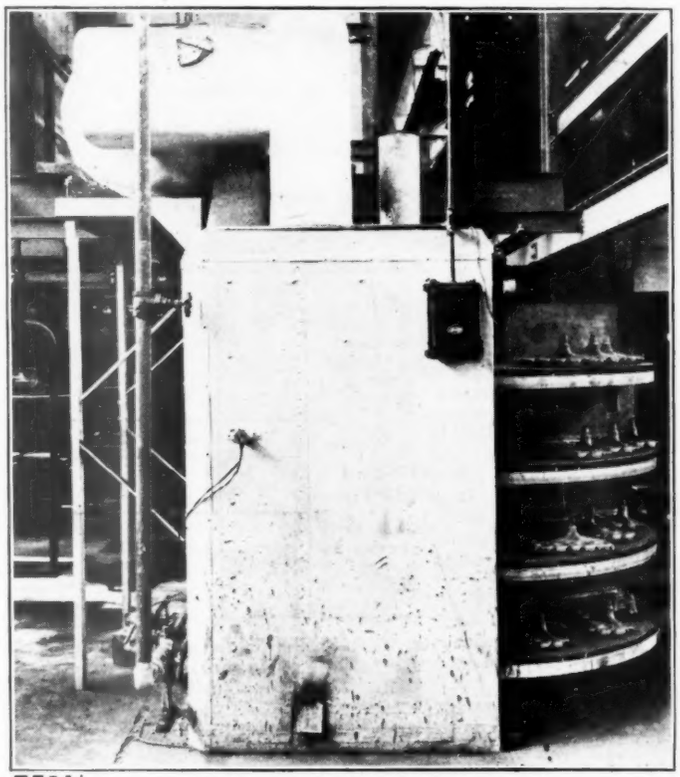

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metal mixture and that allocated to the resultant scrap.

It must be constantly borne in mind, however, that any scrap, whatever it may be, can only be valued at market price and, really, it is only worth that. If, for some reason or other, the foundry were to be closed down, a man could only sell his scrap at the price he could obtain for it on the market. Other special scrap, expensive in its manufacture, would have to be valued on the same principle. The criterion is—what could one buy such scrap for on the market?

For the purpose of examining how the figure of 12s. 6d. per ton is arrived at, which is added to the cost of metal to give the total metal cost, the total metal melted should be analysed. (See Table IV.)

TABLE IV.

	Tons	Cwts.	Qrs.	Lbs.	Per cent. on total melted.
Good castings ..	2,360	3	3	21	60¼
Returns from M/C shop, etc. ..	53	9	3	24	1
Boxparts ..	108	1	0	11	2¾
Plates, core irons, etc.	158	3	2	19	4
Wasters	84	9	2	7	2
Scrap, risers and runners ..	1,163	16	1	12	26¾
Loss in melting ..	125	1	0	18	3¼
	4,053	5	2	16	

It will be seen from this that the good castings form 60¼ per cent. and the tackle 6¾ per cent. of the total metal melted. The tackle made must be considered as good castings. The figures shown in Table V are merely used for illustration, and are representative of melting a standard mixture of iron over a period. Of course, with this method some castings might suffer, as it is possible with certain classes of work for the runners and risers and surplus to equal the weight of the casting, whilst, on the other hand, with a heavier class of work, the surplus metal would probably only form a small percentage of the weight of the casting. The loss on melting is best calculated separately for differing metal mixtures, as naturally their cost varies too.

TABLE V.—*Cost per Ton of Iron Melted.*

	s.	d.
Ganister, 52 lbs.	0	5
Limestone, 52 lbs.	0	2
Stores, bricks, etc.	0	2
Labour, attendants, etc.	1	6
Coke, 2¼ cwts.	3	0
Maintenance, repairs, power, laboratory	0	5
Depreciation, rent, rates, taxes	0	5
Loss in melting	2	5
	8	6

$$\text{On good castings + tackle} = \frac{100}{60 + 6\frac{3}{4}} \times 8\text{s. } 6\text{d.} = 12\ 6$$

Supposing, when estimating for a casting where an abnormal surplus of metal was expected, due to a large head being required and liberal machining allowances, then this could be dealt with specially. Taking an example for the purpose of illustration, a casting weighing 7 tons finished may be considered. In order to ensure soundness, a 12-in. allowance for head was made. With extra weight required for machining allowances, it is possible that 12 tons would have to be taken in the ladle, which would mean at least 12 T. 10 C. charged on the cupola. The estimation for the cost of the metal would therefore be, allowing as before £4 for the metal and 12s. 6d. per ton for melting costs:—

	£	s.	d.
7 tons at £4 12s. 6d. per ton =	32	7	6
+ 5 tons 10 cwts. at 12s. 6d. per ton =	3	8	9
7)	35	16	3
	5	2	4 per ton.

In the case of some rolls, for instance, it has been found that their finished weight is only 50 per cent. of the metal required in the ladle for casting, which, it will be agreed, increases the cost of the metal at the spout, based, of course, on the finished weight. So it is quite easily understood why the foundry manager loses his temper when he sees one or two tons of spare metal on the floor after the cupola bottom has been dropped. He realises that the percentage of good castings to total metal melted is going to drop, thereby increasing the total metal cost.

Allocation of Overheads

This aspect of foundry costs, too, is a very vexed question, both as regards the estimated figure for overheads, but more especially the method adopted to recover them. No doubt some foundries to-day still base their overheads on weight, but this method is definitely wrong where the castings produced vary considerably in weight and cost of manufacture. A specific case can be assumed to illustrate this point. In the same floor space in the foundry, it is possible to make either a 50-ton plain casting or a 10-ton turbine casing, taking practically the same time as regards direct costs. Supposing that the plain casting costs for direct labour are £1 5s. per ton and the turbine casing £6 10s. per ton, and that 150 per cent. is the overhead figure. Then the total amount of overheads derived from each respectively would be:—

Ingot mould 50 × £1 5s. = £62 10s.
+ 150 per cent. = £93 15s.

Turbine casing 10 × £6 10s. = £65
+ 150 per cent. = £97 10s.

Thus the total overheads are practically the same, obtained in the same time from the same floor space.

With the overheads expressed on a weight basis it can be assumed, for the sake of argument, that the overhead figure is £5 per ton; then the plain casting would contribute £50 × £5 = £250 and the turbine casing only £10 × £5 = £50 towards the overhead charges. The selling price of the two castings by the respective methods may be estimated. (See Table VI.)

The selling price, calculated from the weight basis for overheads, for the plain casting would not be competitive, whilst that for the turbine casing would be definitely a cut price. The best method, therefore, is one basing the overheads as a percentage of the direct costs. In this way the respective jobs carry the legitimate share of the oncost, and if it is possible to allocate a definite percentage to the different kinds of moulding, viz., green-sand, dry-sand and loam moulding, so much the better, as then the allocation is even more accurate. It would probably be found that the cheaper class of moulding would require a higher percentage oncost, as one must always keep in mind the total sum of money to be recovered as overheads. For instance, castings costing 1s. per cwt. for moulding would contribute 2s. per cwt. if 200 per cent. oncost was used, whilst a dry-sand casting at 4s. per cwt. moulding, with only 100 per cent. oncost would give 4s. per cwt. towards the overheads. In this way it will be appreciated that the overhead figure is no indication of the efficiency of the foundry, unless, of course, a definite comparison could be made between two foundries making identical castings as regards weight and cost of manufacture.

Tackle and Boxparts

With regard to the question of tackle and boxparts, it is best to pay for these items with the first order. It is all very well trying to take a long view and decide that such costs will be spread over a certain number of castings or, on the other hand, to state that the tackle is standard and will suffice for several types of jobs, but it is much more satisfactory if the cost is booked against the first order. It is galling sometimes, when it is known that a competitor has the tackle for a certain job and so has an initial advantage, but this situation could be viewed, as a matter of policy, that once the tackle is made, even though by so doing a loss had been incurred, yet when further inquiries are received for the same work, the firm is then in an as advantageous a position to quote as the competitor.

TABLE VI.

	150 per cent. on direct cost.			£5 per ton overheads.		
	£ s. d.	£ s. d.		£ s. d.	£ s. d.	
Direct cost ..	1 5 0	6 10 0		1 5 0	6 10 0	
Overheads	1 17 6	9 15 0		5 0 0	5 0 0	
Metal cost ..	4 12 6	4 12 6		4 12 6	4 12 6	
10 per cent. profit ..	0 15 0	2 1 9		1 1 9	1 12 3	
Carriage ..	1 0 0	1 0 0		1 0 0	1 0 0	
	9 10 0	23 19 3		12 19 3	18 14 9	
Without profit ..	(8 15 0	21 17 6		11 17 6	17 2 6)	
Total overheads recovered ..	93 15 0	97 10 0		250 0 0	50 0 0	
Per cent. over heads	150	150		400	77	

What should be included for tackle in the selling price? It can be assumed that the direct cost is 6d. per cwt., and to this must be added, say, 150 per cent. overheads, making 1s. 3d. per cwt. Now, regarding the estimated cost of the metal, the melting loss, the cost of melting and the depreciation between metal-mixture cost and scrap value must be recovered. Where box parts require machining and fitting with pins the machine shops' costs, which include their oncost, must be added. The value of tackle and box parts, for the purpose of stock-taking should be taken at scrap value, less, if deemed necessary, cost for removal of same in anticipation of any such eventuality.

TABLE VII.—*Cost of Tackle for Specific Job to be Included in Estimate.*

	Per ton. £ s. d.
Direct cost	0 10 0
+ 150 per cent. overhead	0 15 0
+ melting cost	0 12 6
+ difference between metal mixture cost and scrap value	1 0 0
	2 17 6

Regarding standard tackle, which can be used until it is of no further practical use, this should be taken into consideration as depreciation spread over a given period or a certain number of castings.

Patterns

Another cost, which appears at times to assume gigantic proportions, especially to the customer, is that of the pattern. Generally the pattern should be quoted for separately, as a lump sum, or included in the selling price for the casting or castings at so much per cwt. To compile such an estimate, the direct cost should be taken into account plus the overheads of the patternshop expressed as a percentage of this, plus the estimated amount of materials required at the current prices. This is the only correct method of arriving at a true cost, and it is rather surprising to find some foundries resorting to the practice of spreading the cost of their pattern-making over the whole of the output of castings, since some castings not making use of the patternshop must still help to pay for the upkeep of the patternshop. A cost sometimes overlooked by the person compiling the estimate for an intricate casting is the time spent by the patternmaker in the foundry setting branches on a loam job, for instance, or helping in the closing of a mould containing a number of cores, or of altering coreboxes.

(*Concluded on page 164.*)

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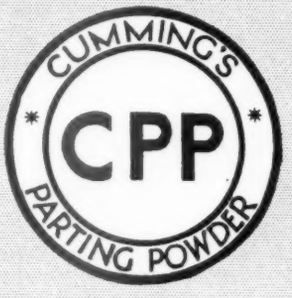

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This Week's News in Brief

Trade Talk

MESSRS. WALTER MACFARLANE & COMPANY, Saracen Foundry, Possilpark, Glasgow, have received a contract for the supply of traffic-direction signs for one-way traffic in the central area and Swan Street for the Manchester Corporation.

MESSRS. PETER & MARK HURLL, LIMITED, Garliston Works, Glenboig, have received a large order for firebricks from a Canadian iron and steel corporation. The contract calls for the supply of 200,000 square bricks and fireclay.

A FIRE BROKE OUT, on Saturday, at the premises of Messrs. J. & J. Wiggin, Limited, hardware manufacturers, Old Hall Works, Bloxwich. The fire was extinguished after three hours, the flames having at one time reached the foundry.

OWING TO THE DEPLETION of stocks and the demand for "Lowmoor C.B." cold-blast pig-iron and "Denby B.B." semi-cold-blast pig-iron, the Low Moor Iron Company, Limited have put a furnace in blast at Low Moor early this week.

MESSRS. D. & J. TULLIS, LIMITED, Kilbowie Iron Works, Clydebank, are to supply the Eastville Institution, Bristol, with an all-metal washing machine with a brass inside shell, 34 in. in diameter by 72 in. long, of the ball-bearing type, for Bristol Town Council.

LAST FRIDAY EVENING the employees of Bonnybridge and Castlecary brickworks of Messrs. John G. Stein & Company, Limited, were entertained by the firm in the Town Hall, Falkirk, when Colonel Alan Stein, M.C., chairman of the firm, presided over a company of about 600.

MESSRS. AITCHISON, BLAIR & COMPANY, LIMITED, Clydebank, are supplying the propelling machinery, consisting of triple-expansion engines with modern improvements to ensure economy and smooth running for the steam yacht of 325 tons which has just been launched from the yard of Messrs. Scott & Sons, Limited, Bowling, for Mr. John Campbell Blair, of Inverary.

COATBRIDGE TOWN COUNCIL are submitting to Sir Arthur Rose, Commissioner for Scottish Special Areas, a scheme for the revival of the pig-iron industry and the clearance of water-logged mines. It is also being requested by the Town Council that an interview should be given by Sir Arthur Rose, at which employers of labour in the town would be invited to attend.

THE INTERNATIONAL MEEHANITE METAL COMPANY, LIMITED, has now issued licences to the following European firms:—Ashmore, Benson, Pease & Company, Limited, Stockton-on-Tees; Ealing Park Foundry, Limited, London, W.5; Cameron & Roberton, Limited, Kirkintilloch; Winget, Limited, Rochester; G. M. Hay & Company, Limited, Bridgeton, Glasgow; Fürstlich Hohenzollernsche Hüttenverwaltung, Laucherthal, Germany; A. Stotz A.-G., Kornwesthein, Stuttgart, Germany; Société de Produits Métallurgiques, Paris; Etablissements Zickel-Dehaitre, Paris; and Fonderia Milanese di Acciaio Vanzetti, Milan.

A STRIKE OF THE MOULDERS employed at Messrs. M. Cockburn & Company, Limited, Gowanbank Iron Works, Falkirk, was the means of throwing a large number of foundry employees idle for three days last week. The dispute arose in connection with the loss of certain castings. At a largely-attended meeting of the strikers on Tuesday, it was resolved that a deputation meet the management of the foundry to ascertain whether the points at issue could be satisfactorily adjusted to enable an early resumption of work to be made. At a meeting between strikers and employers later in the day an agreement was reached and arrangements made for the resumption of work on Thursday. The dispute was regarded as a purely domestic matter.

A LARGE PARTY of the students attending the patternmaking and foundry classes at the new Trades School of the Glasgow Corporation Education Committee took advantage of the invitation of Messrs. Harland & Wolff, Limited, to visit their Clyde Foundry, Govan. The students evinced much interest in the patternshop and its equipment of modern tools, as well as the equipment of the foundry for the production of the largest castings called for by modern shipbuilding requirements. The work in hand, consisting of some of the largest turbine and other marine castings, were explained to the lads by the officials of the firm. At the conclusion of the visit Mr. Young, foundry manager, and his assistants, were warmly thanked for the trouble they had taken to make the visit instructive and interesting. Thanks were also accorded to the directors and Mr. Wallace, general manager, for having granted permission for the visit.

Foundry Costing

(*Concluded from page* 162.)

This Paper would be incomplete without some reference to that ever-present enemy—the waster. To-day, with prices so low, it must be assumed, for estimating purposes, that wasters must not be made, and that any wasters that are made must be regarded as a definite loss on the particular order. However, as wasters do occur, some people add, say, 5 per cent. to the direct cost to allow for the cost of wasters, and in this way they bear the share of the overheads too. Probably this is the wisest method to adopt, although the cost of wasters could be recovered in the overhead charges. At any rate, it is contended that defective castings should be booked against the order, thus showing a loss on that particular order.

The author can only present the foundryman's view of costs and discuss the various controversial subjects involved from that standpoint, but if his remarks result in directing more attention on the part of the actual personnel in the foundry to them, then he shall have achieved his objective. It is a matter for serious thought when, generally speaking, the costing in foundries leaves much to be desired, and, if some standard system can be devised, it will be a matter for congratulation for those connected with the project.

Contracts Open

Siam, April 5.—1,610 wheel tyres, for the Royal State Railways of Siam. The Department of Overseas Trade. (Reference G.Y. 14,800.)

Liverpool, March 1.—Supplying and erecting 900 tons of steelwork at the Liverpool Airport, Speke, for the Corporation. The Land Steward and Surveyor, Municipal Buildings, Liverpool. (Fee £3 3s., returnable.)

Shardlow, March 1.—6,320 yds. of 5-in. pipes and 3,980 yds. of 4-in. concrete-lined iron pipes, for the Rural District Council. Messrs. Elliott & Brown, Burton Buildings, Parliament Street, Nottingham. (Fee £3 3s., returnable.)

Alfreton, March 12.—1,000 yds. of 12-in. and 1,450 yds. of 9-in. iron pipes, with specials, etc., for the Urban District Council. Messrs. Elliott & Brown, Burton Buildings, Parliament Street, Nottingham. (Fee £3 3s., returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

A. S. Thorne & Company, Limited.—Capital £300. Structural engineers, founders and smiths. Director: A. S. Thorne, 63, Heigham Road, Norwich.

Burton Engineering Company (Boston), Limited.—Capital £100. Founders in iron, steel, brass and other metals. Director: G. H. Burton, 35, Main Ridge, Boston, Lincs.

Whyte & Edward (Metals), Limited.—Manufacturers and merchants of metal, machinery, etc. Capital, £2,500. Subscriber: D. S. Whyte, 20, Jedburgh Road, Dundee.

Hobday, Limited, 57/59, Aston Brook Street, Aston, Birmingham.—Capital £1,000. Art metal craftsmen and general brassfounders. Directors: T. H. Hobday and Miss H. D. Genders.

A.R.M., Limited, Dorland House, Regent Street, London, S.W.1.—Capital £100. Ironmasters and founders, steelmakers, etc. Directors: I. S. Miller, H. J. Henbrey, M. R. Proudlock and C. Sinclair.

Personal

DR. R. E. SLADE, managing director of Imperial Chemical Industries, Limited, at Billingham-on-Tees, who has been appointed research director of the firm in London, has been made a presentation by the staff at Billingham.

BAILIE WILLIAM SMART, of Motherwell, has just been appointed as organiser for the West of Scotland Division of the Iron and Steel Trades Confederation. Bailie Smart, who has been employed at the Dalzell Works of Messrs. Colvilles, Limited, Motherwell, since his youth, has been prominent in the trades-union movement for many years.

MR. F. A. HARPER, who has had to relinquish his position as honorary secretary of the Middlesbrough Branch of the Institute of British Foundrymen, on removal to Lancashire for business reasons, has been succeeded by Mr. D. Anderson, of 24, Stockton Street, Middlesbrough. Mr. Harper has been an extraordinarily capable secretary, and has been largely responsible for retaining the interest and usefulness of the Middlesbrough Branch. He was responsible for the organisation of the Conference which was held in Middlesbrough in 1930.

MR. JAMES WILSON, B.Sc. (Glasgow), B. Com. (London), has been appointed Vice-Principal of the Municipal Technical College, Coventry, with a view to succeeding the present Principal, who is due to retire next year. Mr. Wilson has for the past two years been actively engaged in the lay-out and equipment of the workshops and laboratories in the new Stow College of Engineering and Allied Trades, built at a cost of £170,000, and opened last September. Mr. Wilson will enter upon his new duties at the beginning of April.

Will

STARLING, EDWARD CHARLES, works manager of C. Willetts, Junior, Limited, crane makers, ironfounders and engineers, Colonial Works, Cradley Heath £1,069

Obituary

MR. ALVERO HOLLOWDAY, sales engineer for Messrs. Ruston-Bucyrus, Limited, of Lincoln, has died. He had a wide practical knowledge of excavators gathered from large contracts, including Heysham Harbour and Immingham Docks, where he was employed respectively as chief plant engineer and chief mechanical engineer.

MR. R. T. NEVILL, whose death has occurred at a Cardiff nursing home at the age of 41, latterly held an appointment as the representative in the East of Messrs. Richard Thomas & Company, steel and tinplate manufacturers, which office he relinquished a year or so ago. Previously he was manager of a foundry at Llanelly.

MR. WILLIAM SISSON, founder and chairman of the firm of W. Sisson & Company, Limited, engineers, of Gloucester, died last week. Mr. Sisson, who was 81 years of age, obtained a Whitworth Scholarship in 1874, and entered the College of Physical Science, Newcastle-upon-Tyne, and the Royal College of Science, Dublin. After eleven years with Messrs. Cox & Company, of Falmouth, he acquired the business of Messrs. J. J. Seekings & Company, marine-engine builders, of Gloucester, and was joined by his brother, Mr. Arthur W. Sisson, also a Whitworth scholar.

Industrial Progress in Glasgow

An interesting brochure describing some of Glasgow's new products and processes has been issued by the Development Board for Glasgow, and should do much to counteract the unfortunate impression that the industrial capital of Scotland has not moved with the times in adopting new methods. While only a few firms are dealt with in the publication, they comprise establishments employing from less than 100 workers to those with thousands of hands on their pay rolls. The brochure is exceedingly well illustrated with photographs of the works concerned. In the case of some of the newer industries the story is one of enterprise and venture coming out on top. Copies may be obtained from Mr. John Fraser, secretary, Development Board for Glasgow and District, 7, West George Street, Glasgow, C.2.

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Raw Material Markets

That the iron and steel industry has managed to pass through what has been a very slack period, so far as new business is concerned, without any diminution of output, is ample proof of the heavy contract commitments that were entered into by consumers a month or two back. As regards pig-iron, deliveries have generally been taken out at a satisfactory rate. More inquiries are now circulating in the markets, and an early return of activity is expected.

Pig-Iron

MIDDLESBROUGH.—Inquiries are now circulating for spring requirements of Cleveland foundry iron, and more interest is being generally taken in the markets, as a number of large contracts are due to expire shortly. The home demand is heavy, absorbing practically the entire output of the furnaces in blast, and there are indications of still further expansion in this direction. Quotations are unchanged for all areas.

The East Coast hematite trade continues to develop favourably. New business is coming along in an encouraging volume, and deliveries against old contracts are heavy. The official scale of delivered prices is unchanged, No. 1 grade of hematite being 69s. delivered Middlesbrough, 71s. delivered North-East Coast, 75s. delivered Scotland, 76s. delivered Lancashire, and 79s. delivered South Staffordshire. East Coast hematite is still cheaper than West Coast material in the principal English steelmaking centres, particularly Sheffield and the Midlands.

LANCASHIRE.—The majority of foundries in this area are well covered as regards supplies of pig-iron for the next month or so, and hence it is not expected that anything in the nature of a buying movement will be seen just yet. Taking it all round, there is quite a good demand from this area for the common irons, but there is definite room for expansion in several directions. The market is steady generally, with current offers of Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron equal to Derbyshire quoted for delivery to Lancashire foundries on the basis of 74s. per ton, Northamptonshire being offered at 72s. 6d., Scottish foundry at from 81s. 6d. to 82s. 6d., East Coast hematite at from 75s. to 76s., according to grade, and West Coast hematite at around 78s. 6d.

MIDLANDS.—Although the demand for foundry iron in the Midlands is not quite up to expectations, there has been a steady expansion since the beginning of the year. The demand for builders' castings is expected to pick up within the course of the next few weeks. There have been no changes in prices. The controlled figures delivered Birmingham and Black Country stations and subject to rebate to large consumers are 67s. 6d. per ton for Northants No. 3 and 71s. per ton for Derbyshire, Staffordshire and Lincolnshire No. 3. In the better classes of iron for the general engineering and jobbing foundries trade keeps up to a moderate level. Medium-phosphorus pig-iron is between 72s. and 80s., low-phosphorus (including Scottish No. 3) is 85s. to 87s. 6d., and refined iron from £5 7s. 6d. upwards delivered Midland points. There is not likely to be much change in the market for hematite pig-iron so far as buying is concerned. Prices are firm and there is no sign at all of any weakening. The controlled rates for West Coast and East Coast hematite are 84s. 6d. and 78s. per ton respectively delivered the Midlands, and Welsh hematite, although uncontrolled, is offered at the same rate as East Coast.

SCOTLAND.—Conditions show no change in the Glasgow iron market, the call for Scottish foundry still being disappointing. There is no change in quotations at 70s. per ton f.o.t. furnaces for No. 3, with 2s. 6d. per ton extra for No. 1 grade. The light-castings section of the trade is still active, and the outlook is promising. The official prices for Cleveland iron are unchanged at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow for No. 3. Consumers are well bought and steady deliveries are being made against existing contracts.

Coke

Activity in foundry coke is at present largely confined to the purchase of occasional odd lots to supplement present contracts. Quotations for delivery to Midland points are unchanged, as follow:—Best Durham coke, 36s. to 40s.; other grades, down to 34s.; Welsh coke, 35s. to 45s., according to quality; Scottish low-ash coke, 40s. to 41s. per ton.

Steel

Rather quieter conditions have developed in the steel markets, but on the whole the trend of business is satisfactory, states the official report of the London Iron and Steel Exchange. The steelworks have large tonnages of orders in hand which should keep them busy for some time to come in spite of the heavy deliveries which are being made. The demand for semi-finished steel has shown a slight improvement lately, and it is understood that in some cases stocks at the consumers' works have been reduced. British users are placing comparatively little business with the Continent, although cheap offers are still being received. In the finished-steel section of the market, fairly active conditions rule, and, although there is some irregularity in the different departments of the industry, most of the makers are well employed. The demand continues to be chiefly on home account, but the volume of inquiry from overseas has improved.

Scrap

Prices of cast-iron scrap are generally firmly maintained. In the Cleveland district, good machinery metal is selling at 55s. per ton. Foundry cast-iron scrap is in better demand, and up to 53s. 6d. has been paid in some cases. There is a good demand for cast-iron scrap in the Midlands. Heavy machinery metal in handy pieces is now at 56s., good heavy at 52s. 6d. and clean light at 47s. 6d., all delivered works. Conditions in South Wales present a different aspect, the demand being very dull. Heavy cast iron is quoted at 50s. to 52s. 6d., light cast-iron scrap at 40s. to 42s. 6d. and good cast-iron machinery scrap in cupola sizes at 52s. 6d. to 55s. Plentiful supplies of scrap iron are available in Scotland. Good, clean, heavy machinery cast-iron scrap, in pieces suitable for foundry cupolas, is moving freely at 55s. to 56s., with ordinary cast-iron scrap to the same specification at 51s. 6d. per ton.

Metals

Copper.—The temporary spurt in the copper market which took place last week, following on the announcement of the American gold-clause decision, was soon spent, and prices further relapsed, in the absence of support, to the lowest seen for a considerable time. The demand from consumers in this country has been far from active, in view of the uncertainty of the outlook, and similar conditions have ruled in the United States. It is not improbable that the fall in values may have a speeding-up effect on the negotiations for an international agreement on restriction of copper output.

Daily quotations :—

Cash.—Thursday, £27 2s. 6d. to £27 3s. 9d.; Friday, £26 17s. 6d. to £26 18s. 9d.; Monday, £26 3s. 9d. to £26 5s.; Tuesday, £26 13s. 9d. to £26 15s.; Wednesday, £27 6s. 3d. to £27 7s. 6d.

Three Months. — Thursday, £27 7s. 6d. to £27 8s. 9d.; Friday, £27 3s. 9d. to £27 5s.; Monday, £26 10s. to £26 11s. 3d.; Tuesday, £27 to £27 2s. 6d.; Wednesday, £27 12s. 6d. to £27 13s. 9d.

Tin.—The weakness in the tin market which became apparent last week has been accentuated, and the fall in prices has now assumed surprising dimensions. Standard metal (cash) is now some £15 to £20 below the level ruling three weeks ago, and may decline further.

Various reasons have been put forward to account for the sudden slump. It seems that the primary cause was the breakdown of the pepper pool, which culminated in the failure of an important Metal Exchange firm. The resulting nervousness, and the demands made in Parliament for an inquiry into the position, have not brought about an atmosphere conducive to business, to say the least. It is stated on the Metal Exchange that the tin pool has made no effort to arrest the decline. This sudden inclination to let prices seek their own level may, of course, be due to ulterior motives, and may have its origin in the recent criticism of the high profits per ton being made by certain producers. It is evident that the fall in values will not be allowed to go further than the "control" intends.

Market fluctuations :—

Cash.—Thursday, £227 5s. to £227 10s.; Friday, £224 10s. to £225; Monday, £220 to £221; Tuesday, £214 15s. to £215; Wednesday, £215 15s. to £216 5s.

Three Months.—Thursday, £224 to £224 5s.; Friday, £221 12s. 6d. to £221 17s. 6d.; Monday, £216 15s. to £217; Tuesday, £212 10s. to £212 15s.; Wednesday, £212 10s. to £212 15s.

Spelter.—The market in zinc has been affected by the general uncertainty evident in the commodity markets, and prices have shown weakness. There has been a fair demand from the consuming trades.

Official quotations :—

Ordinary. — Thursday, £11 15s.; Friday, £11 16s. 3d.; Monday, £11 11s. 3d.; Tuesday, £11 13s. 9d.; Wednesday, £11 13s. 9d.

Lead.—This "has been an absolutely steady market, entirely unaffected by extraneous influences. In this country conditions in the building trade continue satisfactory. The demand for lead for the paint industry and for cablemaking is well maintained," report Messrs. Brandeis, Goldschmidt & Company.

Day-to-day prices :—

Soft Foreign (Prompt).—Thursday, £10 5s.; Friday, £10 5s.; Monday, £10 5s.; Tuesday, £10 6s. 3d.; Wednesday, £10 6s. 3d.

Large Electric Winders

Much interest is being evinced in the construction at the Vulcan Engineering Works of Messrs. Fullerton, Hodgart & Barclay, Paisley, of seven large electric winders for New Consolidated Goldfields, Limited, Johannesburg, South Africa, and this week the visiting parties to the works included representatives of the Mining Institute of Scotland and the National Association of Colliery Managers (Scottish Branch). The winders, of which three have now been completed, are of a particularly imposing type, and the length of the vertical wind—6,500 ft.—is stated to be the deepest single stage in any mining activity. The drums of these gigantic winders have a diameter up to 30 ft., and the rope speed is 3,000 ft. per min.

SILICO MANGANESE SILICO ALUMINIUM
FERRO SILICON 25/30%
CALCIUM SILICIDE
SILICO SPIEGEL
FERRO ALLOYS
J. N. CLIFTON,
53, Victoria Street,
Westminster.
LONDON, S.W.
Telephone: Victoria 1852.
Telegrams: Newclift, Sowest, London.

Sterling

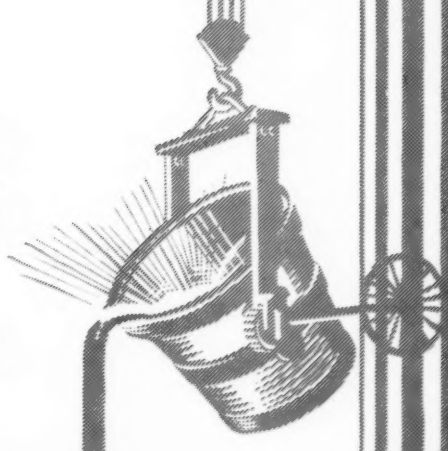
MOULDING BOXES

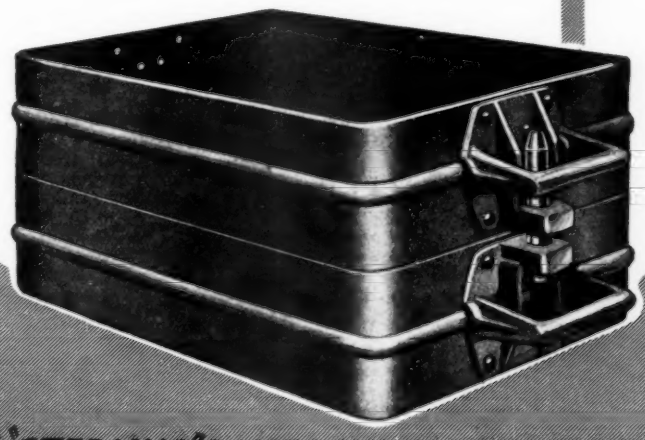
... are designed for the modern foundry

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently.

Sterling Boxes—Save their cost in a few months, and are obviously a sound investment for any foundry.





SPECIFY "STERLING" BOXES WITH YOUR NEXT ORDER

STERLING FOUNDRY SPECIALTIES LTD.

STERLING WORKS **BEDFORD**

LONDON OFFICE: 13 VICTORIA STREET, WESTMINSTER, S.W.I.

RAW MATERIALS—PRICE LIST

(Wednesday, February 27, 1935)

COPPER

	£	s.	d.
Standard cash	27	6	3
Three months	27	12	6
Electrolytic	30	12	6
Tough	28	15	0
Best selected	29	5	0
Sheets	56	0	0
India	40	10	0
Wire bars	30	10	0
Ingot bars	30	10	0
H.C. wire rods	33	5	0
Off. av. cash, January	28	2	$2\frac{11}{44}$
Do., 3 mths., January	28	9	$5\frac{19}{22}$
Do., Sttlmnt., January	28	2	$4\frac{7}{11}$
Do., Electro, January	31	9	$1\frac{1}{11}$
Do., B.S., January	31	2	6
Do., wire bars, January	31	12	$11\frac{5}{11}$
Solid drawn tubes			$9\frac{1}{2}$d.
Brazed tubes			$9\frac{1}{2}$d.
Wire			6d.

BRASS

Solid drawn tubes	$8\frac{3}{4}$d.
Brazed tubes	$10\frac{3}{4}$d.
Rods, drawn	8d.
Rods, extd. or rlld.	$4\frac{1}{4}$d.
Sheets to 10 w.g.	$7\frac{1}{2}$d.
Wire	7d.
Rolled metal	$6\frac{5}{8}$d.
Yellow metal rods	$4\frac{1}{4}$d.
Do. 4 × 4 Squares	$5\frac{1}{2}$d.
Do. 4 × 3 Sheets	$5\frac{1}{2}$d.

TIN

	£	s.	d.
Standard cash	215	15	0
Three months	212	10	0
English	215	17	6
Bars	217	17	6
Straits	217	10	0
Australian (nom.)		—	
Eastern	220	2	6
Banca	219	5	0
Off. av. cash, January	231	6	$0\frac{3}{11}$
Do., 3 mths., January	228	16	$9\frac{9}{11}$
Do., Sttlmt., January	231	6	$4\frac{4}{11}$

SPELTER

	£	s.	d.
Ordinary	11	13	9
Remelted	12	15	0
Hard	10	5	0
Electro 99.9	14	5	0
English	12	16	3
India	12	5	0
Zinc dust	17	0	0
Zinc ashes	3	0	0
Off. aver., January	12	2	$0\frac{9}{44}$
Aver. spot, January	11	19	$10\frac{7}{11}$

LEAD

	£	s.	d.
Soft foreign ppt.	10	6	3
Empire (nom.)	11	6	3
English	12	5	0
Off. average, January	10	8	$4\frac{5}{22}$
Average spot, January	10	6	$5\frac{1}{22}$

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	21	10	0
Do., V.M. ex-whse.	22	5	0
Rods	26	0	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	77	0	0	to	78	0	0
Chinese, ex-whse.					69	10	0
Crude						—	

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	5	0	to	11	12	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£13 0 0
75%	£18 7 6
Ferro-vanadium—	
35/50	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	£29 15 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£33 0 0
Max. 1% car.	£36 0 0
Max. 0.70% car.	£42 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under $\frac{1}{4}$ in. to $\frac{1}{8}$ in.	3d. lb.
Do., under $\frac{1}{4}$ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, $\frac{1}{2}$ in. × $\frac{1}{4}$ in. to under 1 in. × $\frac{3}{8}$ in.	3d. lb.
Do., under $\frac{1}{2}$ in. × $\frac{1}{4}$ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	15	0	to	2	16	0
Bundled shrngs.					2	7	6
Mixed iron and steel	2	10	0	to	2	11	0
Heavy cast iron	2	10	0	to	2	12	6
Good machinery	2	12	6	to	2	15	0
Cleveland—							
Heavy steel					2	12	0
Steel turnings					1	15	0
Cast-iron borings					1	5	0
Heavy cast iron	2	12	6	to	2	13	6
Heavy machinery					2	15	0
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					3	0	0
Steel turnings, f.o.r.					1	14	0
Scotland—							
Heavy steel					2	10	0
Ordinary cast iron					2	11	6
Engineers' turnings					1	19	0
Cast-iron borings					2	0	0
Wrought-iron piling					2	12	6
Heavy machinery	2	15	0	to	2	16	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	24	0	0
Brass	16	0	0
Lead (less usual draft)	9	10	0
Tea lead	6	10	0
Zinc	8	0	0
New aluminium cuttings	66	0	0
Braziery copper	20	0	0
Gunmetal	23	0	0
Hollow pewter	155	0	0
Shaped black pewter	115	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.				12	0	0	
Gas strip				10	10	0	and up.
Bolts and nuts, $\frac{3}{4}$ in. × 4 in.				14	2	6	and up.
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.				10	7	6	
Angles				8	7	6	
Tees				9	7	6	
Joists				8	15	0	
Rounds and squares, 3 in. to $5\frac{1}{2}$ in.				9	7	6	
Rounds under 3 in. to $\frac{5}{8}$ in. (Untested)				8	12	0	
Flats—8 in. wide and over				8	12	6	
,, under 8 in. and over 5 in.				8	17	6	
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)				9	7	0	
Black sheets, 24g. (4-t. lots)				10	10	0	
Galv. cor. shts. (,,)				13	0	0	
Galv. flat shts. (,,)				13	10	0	
Galv. fencing wire, 8g. plain				14	10	0	
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	0	0	to	5	7	6
Tin bars	5	2	6	to	5	7	6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11d.
Rods	10d.
Tubes	13d.
Castings	$10\frac{5}{8}$d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	19/- to 22/-
,, furnace	16/6 to 17/9
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 to 19/2
,,	28×20 ,,	36/4 to 38/4
,,	20×10 ,,	26/- to 26/3
,,	18¾×14 ,,	18/6 to 18/9
C.W.	20×14 ,,	15/6 to 16/6
,,	28×20 ,,	33/- to 33/6
,,	20×10 ,,	23/- to 24/-
,,	18¾×14 ,,	16/- to 17/-

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Feb. 21 ..	27	2	6	dec.	1/3
„ 22 ..	26	17	6	„	5/–
„ 25 ..	26	3	9	„	13/9
„ 26 ..	26	13	9	inc.	10/–
„ 27 ..	27	6	3	„	12/6

Electrolytic Copper

	£	s.	d.		
Feb. 21 ..	30	7	6	dec.	2/6
„ 22 ..	30	0	0	„	7/6
„ 25 ..	29	5	0	„	15/–
„ 26 ..	29	10	0	inc.	5/–
„ 27 ..	30	12	6	„	22/6

Standard Tin (cash)

	£	s.	d.		
Feb. 21 ..	227	5	0	dec.	32/6
„ 22 ..	224	10	0	„	55/–
„ 25 ..	220	0	0	„	90/–
„ 26 ..	214	15	0	„	105/–
„ 27 ..	215	15	0	inc.	20/–

Tin (English ingots)

	£	s.	d.		
Feb. 21 ..	227	12	6	dec.	32/6
„ 22 ..	224	17	6	„	55/–
„ 25 ..	220	12	6	„	85/–
„ 26 ..	214	17	6	„	115/–
„ 27 ..	215	17	6	inc.	20/–

Spelter (ordinary)

	£	s.	d.		
Feb. 21 ..	11	15	0	dec.	1/3
„ 22 ..	11	16	3	inc.	1/3
„ 25 ..	11	11	3	dec.	5/–
„ 26 ..	11	13	9	inc.	2/6
„ 27 ..	11	13	9	No	change

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Feb. 21 ..	14	7	6	dec.	2/6
„ 22 ..	14	7	6	No	change
„ 25 ..	14	2	6	dec.	5/–
„ 26 ..	14	5	0	inc.	2/6
„ 27 ..	14	5	0	No	change

Zinc Sheets (English)

	£	s.	d.		
Feb. 21 ..	23	0	0	No	change
„ 22 ..	23	0	0	„	„
„ 25 ..	21	10	0	dec.	30/–
„ 26 ..	21	10	0	No	change
„ 27 ..	21	10	0	„	„

Lead (English)

	£	s.	d.		
Feb. 21 ..	12	5	0	No	change
„ 22 ..	12	5	0	„	„
„ 25 ..	12	5	0	„	„
„ 26 ..	12	5	0	„	„
„ 27 ..	12	5	0	„	„

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1905	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	11 0 0	11 5 0	11 15 0	12 0 0	10 15 0
1906	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 12 6	12 12 6	12 15 0	12 15 0	12 15 0	13 5 0	12 13 11½
1907	13 5 0	13 5 0	13 15 0	13 15 0	13 15 0	13 15 0	13 17 6	13 17 6	13 17 6	13 2 6	13 2 6	13 2 6	13 10 10
1908	13 2 6	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 11 0½
1909	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 16 8
1910	11 15 0	12 5 0	12 5 0	11 15 0	11 10 0	11 10 0	11 12 6	11 12 6	11 12 6	11 12 6	11 10 0	11 10 0	11 13 4
1911	11 5 0	11 1 3	10 15 0	10 15 0	10 13 9	10 10 0	10 13 9	11 0 0	11 5 0	11 5 0	11 5 0	11 7 0	10 19 7½
1912	11 10 0	11 10 0	11 10 0	11 15 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 12 6	12 18 0	12 15 0	12 2 11½
1913	12 15 0	12 15 0	12 15 0	12 11 3	11 18 0	11 15 0	11 15 0	11 15 0	11 15 0	11 3 0	11 0 0	11 2 6	11 18 4
1914	11 7 0	11 7 6	11 7 6	11 5 7½	11 2 6	10 15 0	10 15 0	12 17 6	14 2 0	13 7 0	11 15 7	11 2 6	11 16 0
1915	11 10 8½	13 12 6	14 8 9	15 0 6	17 17 6	20 17 6	20 17 6	20 6 3	17 12 6	18 1 0	22 13 9	25 2 0	18 3 4½
1916	26 5 0	27 12 6	28 0 0	28 5 0	29 0 0	29 0 0	28 15 0	28 3 0	28 15 0	28 15 0	28 15 0	28 15 0	28 6 8½
1917	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 0 0	28 0 0	28 0 0	28 11 3
1918	28 5 0	28 15 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	28 13 4
1919	29 0 0	29 0 0	29 0 0	28 0 0	28 10 0	27 7 6	27 5 0	29 3 0	32 0 0	33 0 0	36 10 0	40 8 4	31 5 3½
1920	46 10 0	49 15 0	53 15 0	56 0 0	55 10 0	54 10 0	52 10 0	48 10 0	44 3 4	39 2 6	35 17 6	30 8 0	47 4 3
1921	28 10 0	25 17 6	24 5 0	23 3 4	22 0 0	22 0 0	23 10 0	21 12 6	20 0 0	18 15 0	18 3 9	17 2 0	22 1 7
1922	16 17 6	15 13 9	16 3 0	16 10 0	16 4 4½	15 15 6	15 16 3	16 16 0	16 8 9	16 6 3	17 1 0	17 7 6	16 7 5½
1923	18 3 1½	19 1 11½	19 8 0	19 10 0	19 7 0	19 1 3	18 0 0	18 13 1½	19 0 0	19 3 9	19 2 6	18 19 4½	18 19 2
1924	18 13 6	18 9 4½	18 5 0	17 15 11½	17 3 0	17 19 4½	18 7 6	18 8 1½	18 8 1½	17 19 6	17 11 3	17 10 0	18 0 10½
1925	17 8 6	17 1 6½	16 9 4½	16 12 0	16 9 8½	16 9 4½	16 0 6	16 1 10½	16 5 0	16 7 0	16 12 6	16 15 0	16 11 0½
1926	16 14 4½	16 5 7½	16 0 6	15 11 10½	15 11 3	16 0 0	16 16 0	16 18 9	16 14 0	16 18 9	17 10 0	16 19 0	16 10 0½
1927	16 3 1	15 7 6	15 3 3	15 3 1½	14 14 4½	14 11 6	14 1 10½	14 0 0	13 19 6	13 16 10½	13 13 1½	13 3 9	14 9 10
1928	13 0 0½	13 2 6	13 6 0	13 2 6	13 3 0	13 6 9	13 11 3	13 10 0	13 10 7½	13 12 6	13 11 6	13 10 0	13 8 8½
1929	13 11 0	13 13 1½	13 12 9½	13 10 11½	13 9 3	13 8 9	13 11 6	13 7 6	13 7 6	13 5 6	12 18 9	12 12 9½	13 7 5½
1930	12 5 0	11 15 0	11 19 6	11 18 7	11 18 0	11 17 6	11 17 6	11 17 6	11 16 3	11 12 6	11 8 9	11 5 0	11 15 11½
1931	11 4 0	11 0 0	11 0 0	11 0 0	10 13 9	9 18 9	9 13 0	9 5 3½	8 19 0½	9 16 0	9 8 9	9 4 0½	10 1 10½
1932	9 2 9	9 14 4½	9 16 0	9 13 9	9 12 6	9 12 6	9 11 0	9 4 4½	9 11 3	10 12 6	11 5 0	11 7 0	9 18 7
1933	11 15 0	11 15 0	11 15 0	11 15 0	11 17 6	12 4 0	12 10 0	12 10 0	12 12 6	12 15 0	12 15 0	12 15 0	12 4 11
1934	12 15 0	12 15 0	12 15 0	12 17 6	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0	12 18 6½
1935	13 0 0	13 0 0	—	—	—	—	—	—	—	—	—	—	—

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